Report for the Grenfell Tower Inquiry

The application for Building Regulations approval (Part B Fire) in relation to the refurbishment of Grenfell Tower - extent of control, the Building Control process adopted, the referenced guidance and practices adopted

Supplementary Report by

Beryl Menzies FCABE PPBEng CBuildE CABE MRICS

regarding the smoke control installation that formed part of the Building Regulations application associated with the refurbishment of Grenfell Tower

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This is a supplementary report by Beryl Anne Menzies FCABE PPBEng CBuildE CABE MRICS for Phase 2 *of the Grenfell Tower Inquiry relating to the smoke control installation that formed part of the* application for building regulation approval (Part B Fire) for the works undertaken at Grenfell Tower.

Specialist field: fire safety in buildings and Part B (fire safety) of the Building Regulations

Instructing solicitor: Cathy Kennedy

Prepared for: The Grenfell Tower Inquiry

Inspection dates: 27th June 2018 and 30th July 2018

Professional qualifications

Fellow of the Chartered Association of Building Engineers (CABE)

Past President of the Association of Building Engineers (PPBEng) (President May 2009 – May 2010)

Member of the Royal Institution of Chartered Surveyors (MRICS)

Experience

Director Menzies Partners Ltd

Independent Fire Consultant since 1991

Consultant in fire safety and fire related building services. Involved in some of the most significant projects in the UK over recent years as part of the design team formulating fire and life safety strategies or reviewing fire and life safety strategies. Also, providing general advice in relation to Building Regulations compliance.

Carrying out fire risk assessments of a wide range of building uses. Working for local authorities, major property developers and investors.

The work has involved close contact with statutory authorities, public bodies, development corporations, fire brigades, health authorities, and specialist consultants, including the Building Research Establishment.

London Borough of Tower Hamlets 1985 – 1990

A Chief Engineer implementing the Building Regulations and the London Building Acts with responsibility for specialist officers dealing with innovative new buildings under construction.

Greater London Council - Building Regulations Division 1973 - 1985

Trained and promoted through grades within Division to become Group Officer responsible for the Fire Precautions Act and building legislation; and Deputy Senior Surveyor responsible for entertainment and sports licensing in Greater London.

Memberships

Fellow of the Chartered Association of Building Engineers (formerly the Association of Building Engineers).

Member of the Royal Institution of Chartered Surveyors.

Formerly a member of a British Standard Committee involved with the drafting of fire precaution codes (BS 5588); past chair Fire Safety and Means of Escape Sub-committee of the London District Surveyors Association. Member (former) of the Review Panel of the Building Regulations Advisory Committee of the Department for Communities and Local Government for Approved Document B 2006.

Currently a member of the Building Control Performance Standards Advisory Group (BCPSAG) and the Construction Industry Council Approved Inspectors Register (CICAIR) standing panels (Chair of complaints panel; Vice Chair of policy panel). Board member of CICAIR.

Preamble

1. I have prepared this supplementary report on the instructions of the Grenfell Tower Inquiry.

2. The report addresses the system of approval and inspection adopted by the Royal Borough of Kensington and Chelsea in respect of this particular aspect of the works and whether it complied with the relevant legislation, regulations, guidance and industry practice.

3. My instructions require that my report –

   - reviews all relevant documents made available regarding the application for building control approval; and,
   - makes recommendations (if necessary) as to -
   - any further investigations to be carried out; and
   - any further documents that should be obtained.

4. I confirm that I have made it clear which facts and matters referred to in this report are within my own knowledge and which are not. Those that are within my knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

5. My report is based on the information available to date. If additional information is disclosed, my report will be amended as necessary to reflect that information and I will inform the Inquiry of any change in my opinion as a result of the information and why that information results in the change.

6. This report relates solely to the role of the Royal Borough of Kensington and Chelsea Building Control Department in the Building Regulations process of the works at Grenfell Tower - up to and including the issue of the completion certificate.

7. The report does not consider the fire of 14th June 2017 and its events and outcome; this is the subject of reports by others.

8. The report does not address the adequacy or suitability of the guidance available at the time of the full plans application. This will be reviewed by others.

9. This report is based on disclosed information from numerous sources. Where reference is made to specific information in a disclosed document, the unique identification number of that document is shown in brackets { }.

10. This report should be read in conjunction with my main report The application for Building Regulations approval (Part B Fire) in relation to the refurbishment of Grenfell Tower - extent of control, the Building Control process adopted, the referenced guidance and practices adopted, as amended in April 2020 {BMER0000004} plus the appendix {BMER0000005} and errata sheet {BMER0000006}.

11. In this report, I will refer to details and information in my main report and I will only repeat matters from it for ease of reference and where necessary to explain or provide clarity. The cross reference in my main report will be indicated as <para>.

12. The sections of this report follow the outline of those of my main report where possible.

13. The commentary relating to disclosed documents is addressed in the past tense.

14. Recommendations for changes and requests for additional information will be addressed separately in another report.

15. During the preparation of this report I have had sight of the report by Dr Lane Phase 1 Report - Appendix J Lobby smoke control – requirements and provisions {BLAS0000031}. I will make reference to that report where appropriate.

Introduction

16. Prior to the refurbishment Grenfell Tower had a single escape stair approached via a lobby (the lift lobby) that gave access to the residential accommodation on each of the upper levels - level 01 and above.

17. This single stair, the lift lobby and the designated "fireman's lift" together also constituted a firefighting shaft from which the Fire Service accessed the various levels.

18. A smoke control system had been installed when the building was constructed to -

    a. protect the means of escape; and,

    b. to deter smoke entering the stair and thereby assist firefighting.

19. The proposed works to Grenfell Tower included alterations to the existing smoke control system.

20. The existing smoke control system served only the upper residential levels. The amenity spaces on the lower levels were accessed separately. There was no physical connection between the residential and amenity spaces.

21. The fire safety guidance at the time of the construction of Grenfell Tower permitted the single stair in a residential building to act both as an escape stair and a firefighting stair. This was on the basis that it was assumed –

    - A fire would occur within one flat only at any one time. The Building Regulations and guidance/codes did not (and currently do not) address concurrent fires in separate compartments in a building; they do not address arson.
    - The fire would be contained within the flat due to the high level of compartmentation required (that is between flats, between flats and common areas and between flats and ancillary areas).
    - That the requirements of all parts of the Building Regulations were complied with as the requirements were interrelated. This means that:
        - the means of escape was supported by the structural stability afforded by the fire protection to the structure;
        - the spread of smoke into and through escape routes and firefighting access routes was controlled by passive or active smoke control measures;

- fire spread was restricted by compartmentation;
- the surfaces within an escape route and other areas had limited flame spread to deter the rapid spread and extent of fire allowing people to reach exits;
- the construction of external walls and roofs together with the subdivision of unseen cavities did not support the rapid and uncontrolled spread of fire across compartments; and
- the Fire Service was provided with sufficient and easy access up to, into and though the building for personnel and the transport of equipment – a passenger lift being available for the exclusive use of use of firemen in an emergency for the transportation of personnel and equipment.

22. A firefighting rising water main was provided within the firefighting shaft to allow the Fire Service to connect to a water source at each level. In Grenfell Tower outlets from a dry rising main were located in each lift lobby.

23. At the time of the alterations, guidance continued to permit the single stair in a residential building to act both as an escape stair and a firefighting stair.

Summary of my opinion

24. In reaching my opinion, I have applied the standard of what would be expected of a reasonably competent building control body at the relevant time.

25. I consider that the performance based design for the lobby smoke control system {RBK00027392} as conditionally accepted by the Building Control Body (BCB), was acceptable in principle.

26. The adoption of a velocity of at least 2m/s at the open lobby/stairwell door for smoke control was appropriate for the means of escape and firefighting phases.

27. The acceptance of a comprehensive commissioning certificate by a recognised or accredited company as evidence of compliance was not uncommon at the time and was an acceptable process for a BCB.

28. The signed Above Ground Commissioning Report for the smoke control system dated 28 April 2016 {PSB00000224} did not relate to the complete smoke control system as installed and should not have been accepted as evidence of compliant works.

29. I have not seen any disclosure that indicates that the BCB confirmed or witnessed the physical path of the air (smoke) movements away from the stair and that there was no significant inflow from other leakage paths such as the fire flat.

30. I am not satisfied that the effect of the additional makeup/input air required by the BCB in the ground floor entrance was demonstrated as being either beneficial or detrimental to the smoke control system and in particular the direction of smoke flow away from the stair.

31. In my experience systems/installations that have not been subject to modelling are generally demonstrated on-site using a cold smoke test to illustrate the directional flow of smoke, the speed of dispersal and level of visibility. Whilst this will not fully

replicate an actual fire situation, it will be indicative. As far as I can ascertain this was not suggested/undertaken.

32. There is no indication that the BCB was notified in any manner that all the necessary information for the correct operation and maintenance of the smoke control system was passed to the "responsible person". As such Regulation 38 was not complied with.

33. In the absence of a Commissioning Certificate / Report for the smoke control system as installed and non-compliance with Regulation 38, the Completion Certificate for the works set out in the Full Plans application should not have been issued.

Legislation

34. The proposed alterations to the smoke venting system at Grenfell Tower came within the scope of Part B of Schedule 1 the Building Regulations. The scope and application of the relevant legislation is set out in my main report {BMER0000004}.

35. Initially the BCB's control of the works as described in the full plans application was limited to ensuring that the proposals resulted in a smoke control installation on completion that was no worse/provided no less protection than had existed prior to the alterations being undertaken.

36. The design of the proposed installation changed significantly as the design developed and it became a fully mechanical extract system.

37. No information was provided regarding the working of the existing system and as such it was not demonstrated that the various amended proposals would result in a "no worse" situation.

38. This in my opinion extended the control under the Building Regulations to require compliance with the guidance current at that time as far as was reasonable and practical to do so. The BCB appears to have adopted this approach.

Pre refurbishment guidance

39. Whilst it is the responsibility of the applicant to demonstrate that the installation will be "no worse", it is good practice for a BCB to initially check that the description of the existing system reflects that previously approved as an installation may have been subsequently altered without the agreement of the BCB.

40. The BCB can usually carry out this check by reference to their records. However, this was not possible in the case of Grenfell Tower as the records passed to them by the previous authority (GLC) had been destroyed by the Royal Borough of Kensington and Chelsea (RBKC) Building Control Department. In his first witness statement {RBK00033894} paragraph 28, Mr Hanson (the Senior Building Control Surveyor who reviewed the smoke control proposals) states that RBKC Building Control made the

decision in "approximately 2016", to destroy the Section 20 and Section 35/35 records, that had been passed to the Authority on the abolition of the GLC.[1]

41. Personal experience from working in the GLC Building Regulation Division suggests that any approved system of mechanical smoke control for Grenfell Tower would have been the result of discussions between the developer, the Building Regulations Division of the Greater London Council, likely in consultation with The Building Regulations Engineering Group (BREG - that specialised in mechanical and electrical matters) and the Fire Service. The outline details of the system and any conditions related to the acceptance of the system would likely have been set out within the initial Section 34 approval or subsequent Section 34/Section 20 documents.

42. The disclosures {LFB00000129} (two disclosures with one URN) indicate that a consent or consents were issued in 1970, meaning that the original or an early consent was based on the guidance within the 1962 version of CP3 {BSI00000043} and subsequent consents were based on CP 3: Chapter IV: Part 1: 1971 {BSI00001729} with the design of the smoke control system likely being an agreed bespoke installation. There was no guidance for mechanical extract/smoke control systems at the time and they were not common in residential blocks.

43. In the absence of information regarding what was originally approved, in my opinion it would have been good practice for the BCB to refer to the guidance applicable at the time of the construction of Grenfell Tower.

44. Whilst a review of CP3 would not have provided information regarding the Grenfell Tower smoke control system, it would have given an understanding of the fire safety protocol at the time of construction. It would also have assisted the BCB in ascertaining if the initial refurbishment proposal was a "material alteration" {BMER0000004} <70> where the BCB control was limited to ensuring the existing situation was made no worse; or if it was building work that should be regarded as requiring compliance (full or part) with the applicable standards current at the time of the application.

45. CP 3: Chapter IV (1962) Part 1 effectively introduced the evacuation protocol known as "stay in place" - only the fire flat initially evacuates.

46. The 1962 version of CP3 was superseded on 29th October 1971 by CP 3: Chapter IV: Part 1: 1971 Code of basic data for the design of buildings Chapter IV Precautions against fire Part 1 Flats and Maisonettes (in blocks over two storeys).

47. The Foreword to CP3: Chapter IV: Part 1:1971 states external rescue is not always possible and modern traffic conditions may delay Fire Service arrival; also the

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[1] Section 20 of The London Building Acts (Amendment) Act 1939 that allowed the GLC to apply conditions when giving consent to the erection of certain buildings that included tall residential buildings
Section 34 The London Building Acts (Amendment) Act 1939 addressed means of escape from new buildings
Section 35 The London Building Acts (Amendment) Act 1939 addressed means of escape from existing buildings

assumption should no longer be made that entire buildings or even adjoining dwellings need to be evacuated if a fire occurs due to the high level of compartmentation in dwellings. The occupants should be safe if they remain where they are but the possibility that individuals may seek to leave the building cannot be overlooked and provision should be made for the occupants of any dwelling to do so by their own unaided efforts without outside assistance.

48. An overview of CP3 can be found in Dr Lane's Phase 1 Report {BLAS0000003} paragraph 3.2 and Appendix J {BLAS0000031} paragraph J4.2. In paragraph D9.2.9 of Appendix D {BLAS0000025} Dr Lane concludes the original design of Grenfell Tower was consistent with CP3 Chapter IV 1971.

Guidance relevant to the smoke control submission

49. In this section I have set out the guidance relevant to the smoke control system at the time of the full plans application, 4th August 2014. As the Inquiry will see the guidance was the same as that used for the review of the smoke control proposals by the BCB.

Approved Document B (2006 edition as amended)

50. Approved Document B (AD B) 2006 as amended {CLG00000224} incorporated the amendments up to and including those in 2013. Section 2 contained recommendations in relation to means of escape and Section 17 in relation to firefighting shafts.

51. AD B set out that the aim of the smoke control measures for escape was to ventilate the smoke that will pass through a flat entrance door when the occupants escape. It recommended that the common lobby was ventilated "to control smoke and so protect the common stairs." The ventilation was in addition to the recommended fire resistant self-closing doors to a flat entrance and the common stair.

52. Recommendations for natural and mechanical ventilation were given, stating that mechanical ventilation may be provided "to the stair and/or corridor/lobby" to protect the stairs and that guidance on the design of smoke systems "using pressure differentials "is available in BS EN 12101- 6: 2005.

53. AD B recommended that a firefighting shaft should generally be constructed in accordance with BS 5588 – 5, which was superseded by BS 9999: 2008. Clause 17.14 of AD B set out that where its recommendations in relation to escape and compartmentation were adopted, the addition of a specific firefighting lobby between the common lobby and stair was not necessary. In other words, the means of escape measures would generally be adequate for firefighting access.

BS 9991 2011: Fire safety in the design, management and use of residential buildings - Code of practice (31/12/2013)

54. Generally in relation to the works proposed at Grenfell Tower the recommendations of BS 9991 {CTAR00000040} reflected those of AD B.

55. The relevant design guidance was contained in sections 2 - 5. In terms of the construction of firefighting shafts, BS 9991 referred to BS 9999:2008. As regards

smoke control, Clause 26.2.5 of BS 9991 recommended that "A mechanical smoke ventilation system should demonstrate equivalent or better conditions in the lobby or corridor and stairs than the natural ventilation system it replaces." "Note 1: This is usually shown by a comparative computational fluid dynamics analysis."

56. Annex E, paragraph E2 of the Code described two main methods of smoke control - natural and mechanical, adding mechanical "can take the form of a pressure differential system (see E3) or a mechanical smoke ventilation system (see E4)."

57. Paragraph E3: Pressure differential systems were described as pressurization or depressurization systems; pressurization systems can be designed and installed in accordance with BS EN 12101-6.

58. Paragraph E4: Mechanical smoke ventilation systems (MSVS) were described as a vent in the lobby provided to remove smoke prior to it entering the stair.

59. Paragraph E6: Considerations for the selection of a MSVS included "judicial" selection of the ventilation rate and adequate provision for replacement air to ensure extraction without smoke from the flat fire being drawn in. It added, the ventilation rate should be verified through computational fluid dynamic (CFD) analysis or mathematical calculation. A note stated there are numerous types of fan assisted systems and further information can be found in the SCA Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (flats and Maisonettes) (2010).

Smoke Control Association Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes) Revision 1 June 2012 and Revision 2 October 2015

60. Between the commencement of discussions with the BCB in 2012, the full plans application in 2014 and completion of works, the Smoke Control Association (SCA) guidance Revision 1 {LFB00059241} was revised and a second revision dated October 2015 {RBK00002932} was produced.

61. As of December 2020 there have been five editions of the SCA Guidance: first edition 2010; revision 1 June 2012; revision 2 October 2015; revision 3 January 2020; and revision 3.1 July 2020. The 2012 and 2015 revisions were current at the time of the Grenfell Tower refurbishment works.

62. The observations made by Mr Hanson in respect of the submitted details (S1a {RBK00003853} and S2 {RBK00033905}) referred to the first revision of the SCA guidance (June 2012) but only in relation to the components of the system.

63. Whilst the disclosures do not confirm that the SCA guidance as a whole was used in the overall BCB review, Mr Hanson states in his first witness statement {RBK00033894} paragraph 52, that the system was designed in accordance with the principles of the SCA Guidance Revision 01 June 2012.

64. The convention was and is that the guidance current at the time of the Full Plans application is adopted (unless shown to be inappropriate or technically incorrect).

65. The relevant features of the SCA guidance were (my paraphrasing) –

Revision 1 2012:

66. Scope: This document provides performance based guidance on smoke control in common escape routes of apartment buildings, setting out the information and parameters for incorporation into a design utilising calculations and/or computational fluid dynamics (CFD) models.

67. "This document is intended to support the recommendations for smoke ventilation of common escape routes as detailed in the statutory guidance of AD B and supporting guidance of British Standards BS 5588 parts 1 & 5 and BS 9999."[2]

68. Introduction: whilst there are prescriptive methods of providing smoke control these methods cannot always be implemented due to space restrictions and layouts. It has become necessary to develop performance based solutions. These performance-based solutions are becoming more common and are supported by calculations or computational fluid dynamics analysis (CFD).

69. As control systems may be dual purpose - escape and firefighting - consideration should be given to which operational modes require analysis as operational conditions will be different.

70. Objectives and performance criteria: if a smoke control system conforms to AD B there is no requirement to consider objective or performance criteria as the ventilation system is deemed to be suitable by virtue of its prescription in AD B. This section then does not apply.

71. Objectives: it is considered more important to protect the stairs which will be used by greater numbers of people if a fire occurs.

72. Recommendations: any system should be designed to keep the stairs relatively free of smoke. Tenable conditions may only be possible when the apartment door is closed.

73. Mechanical (powered) smoke ventilation: mechanical smoke ventilation may be used as an alternative to natural ventilation systems. As recommended in AD B it is necessary to provide an inlet to the common area to prevent damage to the system as well as to ensure that excessive pressurisation or depressurisation of the ventilated area does not occur. By avoiding excessive pressurisation or depression this ensures that large amounts of smoke are not drawn from the fire apartment and escape doors are not rendered inoperable or pulled open.

74. Design should be based on a single floor level being affected by fire and therefore only the smoke vents on the floor of fire origin are required to open.

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[2] BS 5588 Part 1: Fire precautions in the design, construction and use of buildings. Code of practice for residential buildings. Superseded by BS 9991

BS 5588 Part 5: Fire precautions in the design, construction and use of buildings. Access and facilities for firefighting . Superseded by BS 9999

BS 9999: :2008. Code of practice for fire safety in the design, management and use of buildings. Superseded by the 2017 version.

75. Basic mechanical systems are commonly provided simply as an equivalent to the natural ventilation system as described in AD B.

76. 6.4.2 Mechanical extract with natural inlet: the purpose of a mechanical extraction system is to assist in the ventilation of common access areas. Replacement air forms part of the powered system.

77. 8.2.8 Smoke ventilation fans: at present (i.e. 2012) there is no testing regime within BS EN 12101–3 to cover the use of fans with inverters. Designers of smoke systems who wish to have variable speed operation in emergency mode should satisfy themselves that the combination of fan and inverter are compatible and will operate satisfactorily under the design conditions.

78. Throughout, the Guidance makes recommendations for the specifications to be adopted in relation to equipment forming part of the system.

Revision 2 – 2015

79. Introduction: This document covers information and requirements for the design, calculation methods, installation and testing of systems intended for smoke control.

80. Objectives and performance criteria: It is necessary to consider the objectives and performance of a system through an assessment to ensure a proposed design achieves "equivalence" of a code compliant system; or a detailed design analysis, deterministically[3] assessed by reference to PD 7974 *Application of fire safety engineering principles to fire safety design of buildings.*

81. 6.4.4 Mechanical extract only: The system comprises an extract shaft(s) serving one or more common spaces on all or some of the floor levels; the system uses a single mechanical extract shaft with replacement air typically provided by natural leakage. Air replacement is a key component of a mechanical extract only system and designers should specify how this is to be achieved and how this is to be confirmed and tested on site to ensure there is not excessive pressure on doors making them difficult to open and it does not compromise escape by putting smoke into the common escape routes from the adjoining space.

82. Performance criteria: Where the system performance is being assessed deterministically and not compared to an AD B compliant one, then it will generally be necessary to accept limits for one or more of the performance criteria. The Guidance sets one of the criteria as tenability.

83. 8.2.7 Inverters: Designers should satisfy themselves that the combination of fan and inverter are compatible and will operate satisfactorily under the design conditions.

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[3] BS 7974-0 *Application of fire safety engineering principles to the design of buildings. Guide to design framework and fire safety design procedure* defines a *deterministic study* as methodology, based on physical relationships derived from scientific theories and empirical results that, for a given set of initial conditions, will always produce the same outcome. Deterministic is variously explained in common terms along the lines of a future event can be calculated without the involvement of randomness.

84. 8.2.8.1 Smoke extract fans: All fans should be tested and certified to BS EN 12101-3 *Smoke and heat control systems: Specification for powered smoke and heat exhaust ventilators*. Designers should satisfy themselves that the combination of fan and inverter are compatible and will operate satisfactorily under the design conditions.

Both Revisions:

85. Documentation: "All smoke control systems should be handed over to the end user with a complete set of documentation." "this information should comply with regulation 16B" which required the person carrying out the work to provide sufficient information for persons to operate and maintain the building in reasonable safety.

86. Regulation 16B was replaced by Regulation 38. {BMER0000004} < 105>

87. There was reference in the SCA Revision 2 Guidance (clause 5.3.2.2.2 Performance criteria for time dependant design) to the LDSA[4] fire engineering performance criteria paper "Mechanical Smoke Venting of Residential Lobbies and Fire Fighting Shafts 2006" {RBK00030869}. This was produced by the LDSA following meetings with the Fire Service, CIBSE[5] members and the designers of the fan assisted (FAS) smoke extraction concept. It preceded the SCA guidance and provided guidance on a smoke control submission made within Greater London to a local authority building control body (BCB). The paper set out that the concept is to depressurise the stair lobby by the removal of smoke from residential lobbies to improve escape and firefighting and to reduce the potential for smoke to migrate into the stair; adding that careful consideration should be given to the extract volume to ensure it does not actively encourage smoke movement from the fire flat into the lobby. The paper also recommended validation that could include full scale modelling, scale modelling and CFD modelling.

BS EN 12101 - 6: 2005 Smoke and heat control systems - Part 6: Specification for pressure differential systems - Kits.

88. Reference is made in the SCA guidance and AD B to BS EN 12101 - 6: 2005 *Smoke and heat control systems - Part 6: Specification for pressure differential systems - Kits.* This specification is for calculating the parameters of pressure differential smoke control systems and outlines test procedures for the systems.

89. Details of this British Standard are given in the report by Dr Barbara Lane {BLAS0000031}.

90. In brief, a pressurization pressure differential system pumps air into the space to be protected (lobby, stair, lift shaft) to raise the pressure in the space above that in the fire compartment, thereby pushing against the smoke and deterring it from entering the space to be protected.

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[4] London District Surveyors Association

[5] CIBSE: Chartered Institution of Building Services Engineers

91. The Specification also makes recommendations in relation to "depressurization", where "the objective is to achieve the same protection at the doorway between the depressurized space (e.g. a basement) and a protected space (e.g. a stairwell) as would be achieved by pressurizing the protected space". The specification highlights that "there is no protection of any part of an escape route within the depressurized space itself, which may be entirely filled with smoke, or may even be fully involved in a fire. This constitutes a fundamental difference between pressurization and smoke exhaust ventilation."

92. The British Standards Institute has various categories of standards and defines specification and code of practice on their website as –

93. Specification - a highly prescriptive standard setting out absolute requirements; it is commonly used for product safety purposes or other applications where a high degree of certainty and assurance is required by its user community.

94. Code of practice - recommends sound good practice as currently undertaken by competent and conscientious practitioners. They are drafted to incorporate a degree of flexibility in application whilst offering reliable indicative benchmarks. They are commonly used in the construction and civil engineering industries.

95. Below I have paraphrased aspects and quoted extensively from the BS EN 12101 – 6 Specification by reference to the numbered sections within it to illustrate significant points in its application to a project from a building control aspect. The sequence of headings below does not mirror that in the document.

96. 0.2 Objectives of pressure differential systems: objective of the document is to give information on the procedures intended to limit the spread of smoke. It offers information with regard to life safety, firefighting and property protection within all types of buildings. "Passive differential systems provide one means of improving the level of life safety within a building. A decision as to whether such a system is appropriate to a particular project should be taken in context with the overall design strategy for means of escape, firefighting and property protection within the building".

97. Where the designer is unable to comply with this document in full, an alternative fire safety engineered approach can be adopted. The engineered approach should adopt the functional requirements set out in this document wherever appropriate.

98. 03 Smoke control methods: sets out the techniques most commonly used to limit the degree of smoke spread , or control its effects as:

    "(a) smoke containment .....

    (b) smoke clearance .....

    (c) smoke dilution .....

    (d) smoke and heat exhaust ventilation .....

    (e) pressurization, see 3.1.27

    (f) depressurization, see 2.1.10"

This document provided guidance and information on smoke control using pressurization differentials, i.e. only the techniques given in items (e) and (f).

99. 3 Terms, definitions, symbols and units:

3.1.10: depressurization - smoke control using pressure differentials where the air pressure in the fire zone or adjacent spaces is reduced below that in the protected space

3.1.11: depressurized space - fire compartment from which air and smoke are exhausted for the purpose of depressurization

3.1.18: kit - set of at least two separate components that need to be put together to be installed permanently in the works to become an assembled system. The kit needs to be placed on the market allowing a purchaser to buy it in a single transaction from a single supplier. The kit may include all, or only a subset, of the components necessary to form a complete pressure differential system

3.1.27: pressurization - smoke control using pressure differentials, where the air pressure in the space being protected is raised above that in the fire zone

100. 0.4 Analysis of the problem: "The acceptability of any system ultimately depends upon whether the necessary pressure differential levels and air flow rates are achieved. Guidance on the means of calculating the air supply rates to achieve these levels are given within this document.

101. 1. Scope: (in part) "This document specifies pressure differential systems..... It covers methods of calculating the parameters of pressure differential smoke control systems as part of the design procedure..."

102. "The systems incorporate smoke control components ..... This document gives requirements and methods for the evaluation of conformity for such kits."

103. The Inquiry may be aware that the BSI issued a draft document in 2020 relating to pressure differential systems. DRAFT BS EN 12102 -13 *smoke and heat control systems. Part 13: pressure differential systems (PDS) – design and calculation methods, installation, acceptance testing, routine testing and maintenance.* This draft document is more representative of the form of depressurization used at Grenfell Tower and commonly seen today when compared to that in BS EN 12101-6. This supports my view that the SCA guidance was relevant to the BCB overview.

Guidance applied to the proposed smoke control system

104. In the next paragraphs I have considered the relevance of the available guidance in relation to the proposed system for Grenfell Tower.

105. The primary aim of a smoke control system in a residential block is to deter smoke moving towards the stair and minimise/deter smoke entering the stair when the doors to the flat and stair are open during firefighting operations.

106. The rapid increase in the construction of high rise residential accommodation in the preceding decades had necessitated industry meeting the demand for guidance to support changes in design and having regard to costs (capital and on-going for maintenance) and available space. The SCA guidance was based on/adapted from recognised published authoritative guidance and testing/reports such as those produced by the British Standards Institution (BSI), an organisation that works with and is supported by significant input from industry and the BRE (Building Research Establishment). Whilst design changes and preferences can freely occur, guidance from government and other authoritative/professional bodies generally follows such changes as opposed to leading. Industry bodies are able to provide and amend guidance faster than government. It is my understanding that the "self-regulation" of industry by best practice guidance has been supported by successive governments as being the quickest and most pragmatic way to respond to such changes.

107. In my experience the LDSA Paper of 2006 was replaced by the SCA 2012 Guidance and was not generally referred to at the time of the Grenfell Tower full plans application. The first revision of the SCA Guidance had "contributions" by a member of the City of Westminster BCB, which was a member of the LDSA; the second revision of the Guidance had "contributions" by personnel from the City of London BCB and RBKC BCB (Mr Hanson), the London Fire Brigade and Kent Fire and Rescue Service.

108. The SCA Guidance addressed in this report relates to smoke control in common escape routes in apartment buildings only, stating in the Introduction that the guidance is based around "compliance with Building Regulations" and to improve the conditions for means of escape and firefighting, adding that it references the principles of AD B and BS 9991.

109. It should be noted that both these versions of the SCA guidance state that where the measures relating to means of escape are complied with, no additional recommendations need be made in relation to firefighting shafts. This was also stated in CP3 - please see paragraphs 45 to 48 above.

110. The submitted proposal for the smoke control system to protect the means of escape and firefighting stair in Grenfell Tower was set out in the PSB Smoke Ventilation Technical Submission revision 03 dated 12 June 2015 {RBK00027392}. This was the document formally responded to by the BCB and referenced by the BCB as part of its subsequent consultation with the Fire Service.

111. This was a performance based proposal for a mechanical extract system designed as described in clause 1.1.2 of the document "to provide an average open door velocity, across an open lobby/stairwell door of 2.0m/s. This velocity is in accordance with the recommendations of a Class B pressure differential system as defined in Code of Practice BS EN 12101 Part 6: Specification for pressure differential systems - Kits."

112. The proposed system incorporated mechanical extract from the lift lobby adjacent the stair at the storey level of the fire. The aim was to reduce the air pressure in the lobby below that in the fire flat and stair, causing fresh air to flow into the lobby. The resultant lowering of the air pressure was similar to that achieved by a pressure differential system fully designed in accordance with BS EN 12101-6. However, the proposal was performance based and only adopted the appropriate air flow criteria

across the stair door from the Specification. It did not adopt the recommended pressure differential criteria in the various spaces nor the recommended fan temperature which was appropriate for extracting smoke and hot gases from the fire zone.

113. The PSB design engineer Hugh Mahoney states in paragraph 24 of his first witness statement {PSB00001329} that "the design I developed was for a depressurisation system, in other words a system which achieved smoke control using depressurisation principles achieved by mechanical extraction. Depressurisation systems are one of the most common types of smoke control system used in buildings in the UK." In paragraph 36 of his second witness statement {PSB00001373} Mr Mahoney states a mechanical extract system for smoke control purposes is not a pressure differential system designed in accordance with all the requirements of BS EN 12101-6.

114. In paragraph 37 of his second witness statement {PSB00001373} Mr Mahoney states that a depressurisation system designed in accordance with BS EN 12101 - 6 extracts "air direct from the fire zone." However, the definition of depressurization given in item 3.1.10 of BS EN 12101 – 6 is "smoke control using pressure differentials where the air pressure in the fire zone or adjacent spaces is reduced below that in the protected space." The Inquiry will note the definition includes the reduction of the air pressure in "adjacent spaces". As described in paragraph 91 above, Section 9 of the Specification refers to protection at the doorway between the depressurized space (e.g. a basement) and the protected space (e.g. a stairwell); that the most appropriate use of a depressurization system is likely to be in basement spaces; that there is no protection of any part of an escape route within the depressurized space itself, which may be filled with smoke or fully involved in a fire; and adds "This constitutes a fundamental difference between pressurization and smoke exhaust ventilation." Figure 17, *De-pressurization of basements or of other spaces with no external windows* and figure 18, *De-pressurization in basements*, both indicate extract from the accommodation/fire zone, which would not have been appropriate for residential accommodation. See paragraph 103 above regarding the DRAFT document BS EN 12102 -13, issued in 2020 that is more representative of the form of depressurization used at Grenfell Tower.

115. As described in paragraph 68 above the SCA guidance sets out that it is performance based and that the manner in which it is to be used must be considered so that it remains effective. Within the Introduction of the 2012 revision it states, "Since smoke control systems are usually dual purpose, providing ventilation for means of escape and for smoke clearance by the fire and rescue service, consideration should be given to which operational modes require analysis as the scenario and operating conditions will be different depending upon the choices made."

116. SCA guidance makes no specific recommendations relating to firefighting operations. These will be dynamic at each incident but an experienced competent BCB should be aware it is likely fire fighters will approach a fire from a floor or floors below where they have connected hoses to the rising water main and that the hoses will retain open the doors between lobbies and the stair.

117. In both Rev 01 and 02, the SCA guidance refers to maintaining the stair relatively smoke free indicating that an air flow from the stair enclosure into the lobby might be a suitable performance criterion with a minimum design air speed set to 'prevent ' the flow of smoke into the stair when the stair door is open.

118. Detailed knowledge of the air leakage paths is critical to pressurization and depressurization design and a lack of knowledge in this respect apparently deterred the applicants' advisors from pursuing a CFD model. However, the calculated design for the 2m/s flow velocity from the stairwell to the lobby adopted from the BS EN 12101-6 Specification would have required an assumed value for leakage paths if the existing paths were unknown.

119. Dr Lane in her report Appendix J {BLAS0000031} paragraphs, J1.1.9 to J1.1.11 concludes that the system was ultimately designed to provide an average open door velocity and that the design did not fully meet the performance design criteria in BS EN 12101-6.

120. I do not believe the intent of the design proposal was full compliance with BS EN 12101 – 6. This view is supported by the explanation of the design process as set out in the second witness statement of the PSB design engineer Hugh Mahoney {PSB00001373}. The recommended average open door velocity to satisfy escape and firefighting was taken from BS EN 12101 – 6 as a performance criteria.

121. The recommendations of the various BS EN 12101 Specifications relating to the installation, components, testing and maintenance were relevant and were similarly referenced in the Smoke Control Association guidance.

122. In my experience the SCA guidance was generally recognised as authoritative and relevant and was applied to smoke control schemes at the time of the full plans submission. There was no other performance based guidance available. BS 12101- 6 provided a performance criteria.

123. No guidance existed to address the Grenfell Tower proposal: a partially retained system that was to be modified. The adoption of any particular guidance is not mandatory to achieve compliance with the Building Regulations. As outlined in my main report {BMER0000004} < 118, 120 and 121> an applicant is at liberty to choose how to achieve compliance. The Building Regulation requirements B1 through to B5 are substantive and not prescriptive. The guidance must be appropriate for the situation. No one document is subjugated by another but one guidance document may be predominantly relevant and form the basis of a proposal with benefit from others. However, it should be remembered that guidance is based on the assumption that its inter-related measures are adopted and "cherry picking" from numerous documents is unacceptable without justification and can be inappropriate.

124. I have concluded the principles set out in the SCA guidance were appropriate in the circumstances.

125. I am of the view that BS 9991 and AD B both distinguished between pressure differential systems and mechanical smoke ventilation systems. Please see paragraphs 56 to 59 above where I have set out the distinction as described in BS 9991. Either

type of system if correctly designed would have satisfied the functional requirements of Requirements B1 and B5.

The Building Control process and review

126. This section of my report reviews the role of the BCB in assessing the smoke control proposal that formed part of the full plans submission. The proposal did not accompany the full plans application on 4 August 2014; it was initially submitted by JS Wright by attachment to an email dated 19 January 2015. This was the PSB Technical Submission Lobby Smoke Control Systems Rev 01.

127. An insight into the involvement of the BCB that led to the submission can be seen in the first witness statement of Hugh Mahoney, the PSB engineer who designed the system and produced all the technical submissions, except revision 06 which was produced after he changed employment. {PSB00001329}. This statement also describes the system.

128. Using the paragraph numbers within his first statement Mr Mahoney explains (my paraphrasing) –

    15: Outline requirements of the smoke control system for Grenfell Tower were initially provided by Max Fordham (2014).

    18: There was little information regarding the existing system other than that provided by Max Fordhams. Based on his visit Mr Mahoney concluded it was a natural ventilation system with mechanical boost. There were two sets of shafts; inlets connected vents at low level on the south side of each lobby; the other set being on the north side with vents at high-level.

    22: Max Fordham's proposal was to retain the broad principles of the operation of the existing system but to convert it to a full mechanical push – pull system. {PSB00000236}.

    23: Mr Mahoney concluded this would not be an efficient system due to an excessive pressure and he developed an alternative, reusing existing ducts that would achieve the functional objectives set out in the relevant guidance in place at the time.

    24: Mr Mahoney developed a depressurization system - smoke control using "depressurization principles" achieved by mechanical extraction.

    25: This would reduce the air pressure in the lobby and therefore create a pressure differential between the lobby and the stairwell while the door between them remained closed, preventing smoke from migrating into the stairwell.

    26: Pressure switches caused fans to run down at a lower speed once the pressure differential was in place to maintain the differential and prevent it becoming too high causing difficulty in opening the door from the lobby to the stair (pull required not to exceed 100 N) in line with the performance criteria in BS EN 12101–6. This is the relevant standard for designing PDS's (pressure differential systems) and is therefore referred to in AD B 2013.

27: The system was also designed so that when the stair door was opened and the pressure differential reduced, the pressure switches would ramp up the fans to full speed to maintain an airflow from the stairs into the lobby, which would continue to "prevent" smoke from entering the stairwell. This was in line with the performance criteria set out in BS EN12101– 6 which recommends a minimum velocity of 2.0 m/s through the open stair door. "My" calculations showed the proposed design could easily achieve this {PSB00001233}.

{PSB00001233} as referenced in paragraph 27 of Mr Mahoney's first witness statement, is the Smoke Ventilation Technical Proposal for Stair De-Pressurisation Systems Rev 0. This explains the proposal developed from potential problems with the proposed push/pull system to a de-pressurisation system; that the velocity across the door should be sufficient to meet the requirements for a Class B system as outlined within BS EN 12101 - 6.

In section 2 of the paper System Requirements to BS EN 12101 - 6 are set out as a calculation for airflow through open door; fabric losses;[6] area of pressure relief which outlined that a pressure relief damper was not required as the fans are invertor driven to stop excessive pressure differential.

In section 3 Smoke control components, 3.1 Run and standby extract fan set rated to 300^0C for 2 hours and type tested to BS EN 12101-3 are specified.

30: PSB worked with others to ensure building control was happy with the system. Whilst PSB did not have much direct interaction with building control they received comments on the system from the BCB generally via JS Wright.

38: The system design and description changed as the project developed. Changes largely arose from input by building control and Max Fordham, or client clarification of what they wanted the system to do. However the system operation and performance criteria was maintained.

39: Principal changes –

1) Environmental mode – added to later versions of the technical submissions.

2) Configuration and location of smoke shaft on the lower floor levels – ground level, mezzanine, walkway and walkway +1 (a.k.a. 04). Smoke shafts were to be extended down. PSB was happy with the proposals regarding the scheme; the actual works were undertaken by others. Mr Mahoney understood the shafts were extended down to the ceilings of the ground floor level as single shafts (north and south) with vents into each communal lobby on lowest floor – the system served each floor in the building.

3) Revision 01 recorded the specification and location of the fan sets. Changes made accommodated ventilation cooling, another fan set at walkway level used to extract smoke by the south shaft and an environmental supply fan at walkway level for make-up air via the south shafts in environmental mode. This is reflected in revision 02 onwards. JSW was informed by email in September 2015 that the ductwork

[6] Fabric losses - leakage paths such as gaps or cracks in the building and/or around doors, windows, closed vents etc. leading to external air.

housing the smoke extract fan at walkway level needed to be fire rated. {PSB00000044}.

4) Head of stair inlet – initially an AOV was proposed; the existing penthouse louvre retained as permanent vent. This was indicated as a potential change in revision 02 and confirmed in revision 05.

5) Request by building control March to June 2015 –

- Specification for fan cables changed from FP400 to FP600 – revision 02 onwards
- Removal of paragraph from section 1.1.2 – reflected in revision 03 onwards {PSB00000209}

6) Building control wanted two new smoke ventilators to be added (early 2016) –

- one in entrance to community room at mezzanine level
- one entrance to boxing club at walkway.

These were windows with actuators fitted. They were separate from the main system but building control wanted them to be monitored by the system. JSW placed an order with PSB for control equipment and commissioning of these two new" smoke zones" {PSB00000144}. These were reflected in revision 04 onwards.

7) One final proposed change that was not developed was a dial-up facility for external monitoring. Mr Mahoney believes PSB supplied an auto dialler that was not used; that a separate source supplied an auto dialler and it was linked to the BMS.

40: Mr Mahoney left PSB at the end of February 2016.

42: David Harrison of PSB contacted Mr Mahoney in June 2016 regarding questions raised by building control about the system and he helped with the responses.

43: The first question related to the source of make-up air for the system when it operated in smoke mode on either the ground floor or mezzanine level. Mr Mahoney believed that the question arose because the vented main stair did not extend to these two levels. Mr Mahoney understands that Granville Partlow of PSB informed JSW that make up area could be provided via the main entrance area and if additional air was required, the AOV in the main entrance area (not part of the system) could be interconnected. Mr Mahoney agreed with Mr Partlow's view that the existing arrangements were sufficient, there was no requirement to provide any additional source of make-up air as demonstrated by the commissioning. Produced a response {PSB00001163} and {PSB00001164}.

44: The other question related to building control wanting the flow rates in smoke control mode in m^3/s measured by " some sort of device" instead. Mr Mahoney states the request "did not make any sense to me" - the design was 2 m/s in accordance with BS 12101–6. It is standard practice for flowrates to be measured as PSB had done; Mr Mahoney was not aware of any product on the market that could take the measurement. Mr Mahoney produced a response to accord with this.

129. In his second witness statement {PSB00001373} Mr Mahoney provides no additional information as to why the BCB requested the amendment of section 1.1.2 of Technical

Submission Revision 02 that resulted in Revision 03 being issued. See paragraph 126 (referring to paragraph (39)(5) of Mr Mahoney's first statement) above. The BCB regarded Revision 03 as part of the full plans submission (Mr Hanson referring to it as MOE Obs S1a) and it formed part of the consultation with the Fire Service. Mr Mahoney does, however, provide additional information as to his experience designing smoke control systems, his involvement with the SCA guidance and the background to the development of the design that was issued to the BCB as Technical Submission Revision 02. The second statement also sets out in paragraphs 62 to 69 that the air flow criteria for an open door between the lift lobby and stair and the suggested leakage rate for use in the calculations for a Class B system as described in BS EN 12101-6 (appropriate to satisfy escape and firefighting stages) were adopted but the system was not designed to operate in the same way as a Class B differential system.

The process

130. I have set out below a chronology of events/submissions associated specifically with the smoke control system. This has been compiled from the available disclosures by RBKC and others. Within the chronology there are disclosures listed that were not seen by the BCB but their inclusion assists with understanding how the smoke control installation evolved. Those documents produced by or seen by the BCB are highlighted in green. The "content" column gives a synopsis of the content of the disclosure. Italicised text is my comments.

131. As part of the process the BCB should have established that the guidance followed was appropriate for the project.

132. The disclosures to date and the witness statements of Mr Hanson {RBK00033894} and {RBK00033903} confirm that there is little chronicled detail of the process by which the BCB recorded its review of the submission and the discussions and inspections that led to the installed smoke control system.

133. In my main report {BMER0000004} <Summary page 8 and paragraph 35> I concluded that the relationship between the means of escape group and the other part of the building control department was undefined and unclear to those involved. However, in relation to the smoke control system Mr Hanson clearly took the lead and Mr Hoban and Mr Allen deferred to his advice. This is understandable in that Mr Hanson was part of the Smoke Control Association working party drafting an updated version of the Smoke Control Association Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes).

134. Unfortunately Mr Hanson in his role as "consultant" to building control did not make records of his conversations with the design team responsible for the smoke control alterations and did not record notes of meetings, leaving this to Mr Hoban who appears to have mainly kept any notes made in personal documents that are no longer available. All notes - personal or otherwise - should have been transferred to Acolaid {BMER0000004} <page 23>.

135. The disclosures indicate that smoke control correspondence / documents were sent direct to or copied to Mr Hanson but not always to Mr Hoban.

136. Mr Hanson discussed the proposals direct with the design team, mainly JS Wright. Generally Mr Hanson copied documents to Mr Hoban.

Chronology

137. The BCB terms P1 and P2 refer to a pre full plans submission; S1 refers to a formal full plans submission followed by S1a to denote a subsequent amendment; and S2 denotes a major or complete alteration. As far as I am aware this designation is unique to the Kensington and Chelsea BCB.

138. BCB = Building Control Body; SEA = Studio E Architects; JSW = JS Wright (mechanical and electrical engineers for works); Rydon = design and build contractor; MF = Max Fordham (mechanical and electrical consultants for works); Exova = fire consultant

DATE	RELATIVITY REFERENCE	CONTENT OF EMAIL
22/1/76	LFB00000129	Letter from GLC at Middlesex House to LFB - auto smoke extract to lift lobbies in residential portion tested 12th and 20th January 1976 satisfactory when tested; refers to the letter of consent dated 11 February 1970. Sections 20 and 34. Uses Middlesex House ref AR/BR/2/150917. Subject: Automatic smoke extract and amendment to previously consented to works. Also copy of Section 20 & Section 34 consent to alteration to previously approved plans at ground, and mezzanine – play centre and community areas. *Date is blurred but appears to be 1980.* *The 1962 version of CP3 was superseded by one published on 29th October 1971. This suggests that the 1962 version of CP3 was adopted.*
17/8/12	EXO00000655	Exova internal email – comment "making an existing condition worse"
5/9/12	TMO10042279	MF Stage C Report (Rev B) September 2012 M & E
5/9/12	IBI00000525 RBK00027289	MF Stage C Report. Description: Existing Parts - The existing smoke extract system serving the common lobbies will need to be refurbished and/or modified to reflect statutory requirements and any recommendations made by the statutory authorities regarding this system will need to be considered. Any changes/improvements recommended in the fire risk assessment will need to be implemented. In relation to the non-residential accommodation it is recommended there are separate stairs ; may be necessary. *No evidence document seen by Building Control.*

12/9/12	CST00001481	Exova Fire safety Strategy Issue 1
29/10/12	RBK00003025	Proposed floor plans. *No indication as to which RBKC Department provided this.*
31/10/12	RBK00027142	Exova Outline fire strategy Issue 1
5/11/12	RBK00003044	Pre application submission. BCB response to" BRegs" application Stage P1. Dave Gammon to John Allen. Requested details of smoke ventilation to the common lobbies. Drawing nos. MT13779R. ISS01-GRENFELL TOER-Fss, 1279 RE110 REV05, RE111_REV04, RE112_REV04, RE113_REV04, RE114_REV03
6/11/12	EXO00001371 LBI00000880	Meeting minutes of 6/11/12 between BCB (Dave Gammon and John Allen) and Exova. Dave Gammon of RBKC Building Control had made comments re the fire strategy and had marked up the drawings. Meeting led by Gammon. BCB was not satisfied re walkway smoke ventilation; required details of smoke ventilation to common lobbies.
4/2/13	LBI00002449	By email Mr Allen sent marked up plans to Leadbitter - 1279_RE110_Proposed Floor Plans_Rev05.pdf (681.45 kB); MOE General Floor Plans P1 1279_RE110_Proposed Floor Plans_Rev05.pdf (726.83 kB) *No notes of meeting disclosed.*
11/2/13	LBI00002544	Proposed BCB (Allen/Leadbitter meeting on 11/2/13
August 2013	CCL00000028	Studio E Stage D report. *Relativity gives date as 20/8/13*
17/8/13 -	RBK00026859	RBKC chronology - on this date meeting at RBKC between Studio E and building Control
13/9/13 date given by Relativity	SEA00000097	Exova invitation to Studio E for BCB meeting at RBKC on 17/9/2013
24/10/13	EXO00000430	Exova Outline Fire strategy Issue 2 ref MT14634R *This one of the attachments to {RBK00027290} dated 25 October 2015*
25/10/13	RBK00027287 RBK00002967 RBK00003806	MF Smoke Control proposals setting out existing and proposed systems; dated 25/10/13 Rev A States the existing system is designed to work as a natural system with supply and extract fans for boosting the system manually by fire fighters; each lift lobby has low level air inlet connected to shaft on one side of

		lobby and a high level extract vent connected to shaft on opposite wall of lobby. The existing structure imposes physical constraints for the new system cannot adopt to comply with current smoke control standards. Proposed system will be mechanical not relying on natural ventilation – approximately 15 ach. System also to be used for environmental temperature control. *This one of the attachments to {RBK00027290} dated 25 October 2015*
25/10/13	RBK00027290	Email of this date Studio E to BCB, referencing meeting on 17/8/13 and forwarding proposed fire strategy drawings, Exova fire strategy document and description of AOV upgrade - MT M&E Smoke Control Proposal Rev A.
	SEA00000121 SEA00000149 MAX00004179	*This is a long chain between various parties. The separate ID's allow access to some of the individual emails in the chain.* Email chain starts with email (SEA00000121) on 25/10/13 and ends 8/1/14. Email 25/10/13 Lists drawings as 1279_PL010, PL200 REV 01; 1279_SEA (08) 100 AND 101; M&E Smoke Control Proposals REV A and the fire strategy issue 2 MT14634R Issue 2 (see EX00000218 and EXO0000430 - Outline Fire Safety Strategy Issue 2 dated 24/10/13) Reference to meeting on 17/8/13. SEA issues fire strategy etc to BCB as above, requesting consultation with LFB due to concerns re agreement of AOV proposal; Hanson and SEA speak (no record) and MF emails Hanson (7/11/13) where it is suggested Hanson believes a compliant natural vent shaft is being omitted, and MF explains they and Exova think it is better to provide a more predictable system with mechanical supply and extract as the default mode. Requests meeting w/c 4 November 2013. Email 7/11/13: MF to Hanson responding to Hanson's queries regarding MF Smoke control Proposals document. Email 11/11/13 from Allen (BCB) to SEA - insufficient information to consult LFB; adding provided it can be shown that the new system is no worse than the old system "this will be acceptable; suggests that if no data on existing system is available, measure the current flow rates and provide information about proposed system. Email 3/12/13 from SEA to BCB (Hanson) regarding updated fire access

		plan and stair in foyer. Email 31/12/13 Hoban introduces himself to SEA as responsible surveyor and thanks SEA for preliminary submission and returns marked up plans and observations (P2 is the attachment). Email 6/1/14 SEA to BCB stating SEA will respond regarding fire separation and engineers will address the smoke vent. Email 8/1/14 BCB to SEA (also {RBK00027302})- Hoban states happy to consult LFB as a separate exercise and referencing "fire safety in purpose built blocks of flats items 62.9-62.11" - *This is the LACORS document* Email 8/1/14- SEA passes BCB advice to MF
28/10/13	SEA00009482	Studio E to TMO seeking assistance in gaining BCB response; Mr Hanson had stated he is very busy.
1/11/13	RBK00003018	Stage E Tender Issue dwg. 4614 U(14)01_200 T1 Smoke ventilation schematic Schematic indicates - • extent of supply air shaft is L01 residential and above; supplied by fans at Walkway +1. Existing fans removed and replaced by supply fans between Walkway and Walkway +1 with new horizontal and vertical supply shaft to link with existing at L01 • existing extract shaft at L01 extended from L01 to Walkway +1 • each floor has 2No. supply ducts and 2No. extract ducts • AOV's with window actuators located in lobbies at Walkway, mezzanine and ground levels *This scheme was subsequently amended. Not known if this document was seen by BCB.*
7/11/13	CST00002142	EXOVA Outline Fire Safety Strategy Issue 03 dated 7/11/13 *This is the date of the strategy* States Smoke Ventilation of Lobbies - existing system will be extended down to Walkway + 1 level; supply and extract system to be covered in separate report by MF.
7/11/13	RBK00003017	MF to BCB (Hanson) response to queries raised regarding MF draft report re smoke control system. There follows a discussion between SEA and BCB (Hanson). Attached "our schematic drawing".
11/11/13	SEA00009805	Email from BCB (Allen) to Studio E – insufficient information to consult FRS and states that provided the smoke vent system is no worse than the old it will be acceptable. Outlines way forward if no data on existing system.

3/12/13	RBK00003806	BCB Hanson to SEA - query re escape route. Email has attachment - 1279 SEA (08)101 P2 Quest. Follows on from SEA submission 25/10/13 {RBK00027290} and {SEA00000121}
6/12/13	RBK00027300	Internal email BCB Hanson to Allen (RBKC) - providing means of escape observations, that includes the required information regarding the existing smoke control installation and other aspects relating to the means of escape; and refers to marked up plan P2.
25/10 /13 to 31/12/13	RBK00003864	Hoban advises he is the appointed surveyor and attaches BCB response to Studio E attaching P2 response.
6/1/14	SEA00000159 EXO00000214	Email chain that includes passing P2 comments to Studio E and advising that BCB is not in a position to consult the Fire Service at this stage.
8/1/14	RBK00027302	Email BCB Hoban to Studio E re their requested consultation with LFB regarding smoke vent system – the BCB is happy to conduct separate consultation on smoke vent but requires further information from SEA
8/1/14	RBK00048649	Internal BCB email Hanson to Hoban suggesting response in relation to P2 comments and consultation with LFEPA.
1/3/14	CST00001093	Carl Stokes visited GT on 17/3/14 to gain information regarding servicing etc. Common Lobby ventilation system – • Mechanical extract; two vents each side lobby area; extraction plants and controls etc located in the roof level extraction plant. There is also mechanical extraction in the refuge shoot rooms and mechanical toilet extraction. In the plant room the lobby smoke control extract panel is on the right-hand side. The lobby extraction is activated by the AFD each of the flat lobby areas at ceiling level the extract system works by the events on one side of the lobby extracting inflow on the other side. • In the ground floor lobby area there is a control panel for the smoke extraction system; inside the panel are instructions for the system which also covers the lobby pressurisation fan in the social services area. • Age of devices ranges from 2007 – 2009 and pre-1988. The letter goes on to state that both of the lifts are fire fighter evacuation lifts.
22/4/14	PSB00001331	Smoke ventilation Technical Proposal for Stair De-Pressurisation System Rev 0 – issued for comment *No disclosure to substantiate seen by BCB.*
6/5/14	MAX00001651	MF Smoke Ventilation Analysis Rev A
13/5/14	MAX00002335	MF Smoke Ventilation Analysis Rev B- by calculation demonstrates comparison of existing to new. Included schematic drawing numbered

		U(14)01_200T2, that included fans for general and smoke supply. States flow rate was 1.1 - 1.2m^3/s; proposed 5.0m^3/s; adds proposed is constricted by existing shaft dimensions. *No disclosure to substantiate seen by BCB.*
2/6/14		REFURBISHMENT WORKS START
4/8/14	RYD00014378 RYD00014379	BUILDING REGULATIONS SUBMISSION An email dated 4/8/14 from Studio E to BCB with the full plans application attached; no plans or details attached.
5/8/14	RBKC Chronology RBK00058146	TMO submits BRegs application for new floor areas, new over - cladding and windows, new heating system, reconfiguration of podium and entrance. REF FP/14/03563
29/8/14	RBK00013223	BCB visits site. John Hoban. Pre-start visit. Satisfactory.
10/9/14	MAX00004451	Email - Rydon still looking at smoke vent system to lobbies
18/9/14	RYD00018101	Email Studio E to Rydon re P1 comments by RBKC which are attached.
24/9/14	RYD00018742	Email Studio E to BCB forwarding package of drawings for GT. States is only part of package rather than "swamping you". *THIS WILL BE REFERENCED AS S1 BY RBKC - FIRST SUBMISSION OF DETAILS FOR FULL PLANS APPLICATION. There are no details of the smoke control system.*
24/9/14 - 21/11/14	RBK00002633	Email chain between BCB and Studio E and Exova Includes on 18 November the BCB S1 comments; and in his email BCB Hoban highlights significant points for new architect. 24/9/11 drawings – 1279 SEA (08) 100 & 101; 1279 SEA (08) 100B,A1-000, 101B A1-000; 1279 SEA (06) 100, 1279 (05) 101 REV 01, 102 REV 01, 103 REV01, 1270 (04) 100, 101 REV 01, 102 REV 02, 103 REV 01, 105, 108 109. No Exova fire strategy

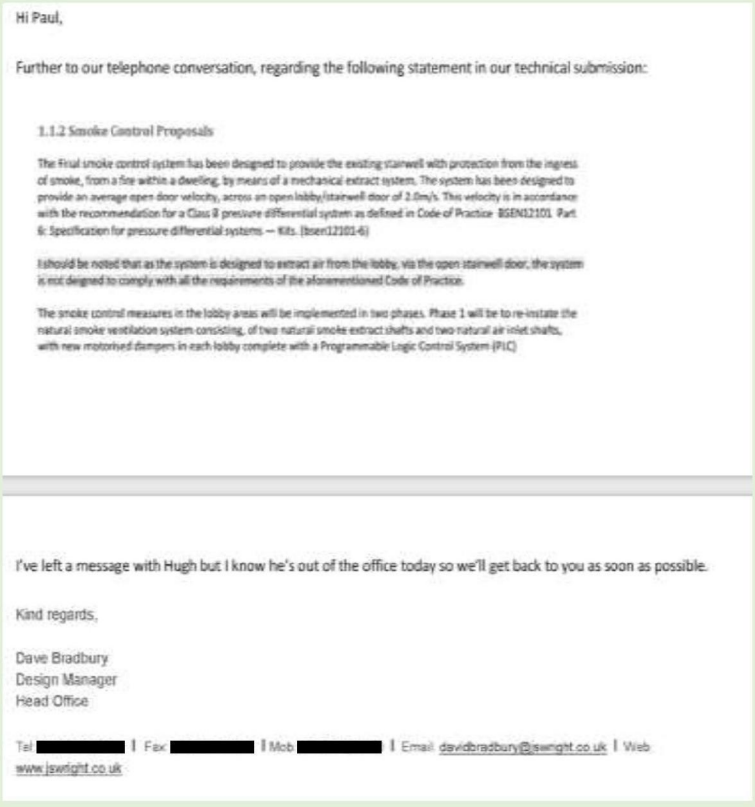
29/9/14 at 16.24hrs	RBK00048693	Hoban requests observations from Hanson under Part B for proposals submitted 24/9/14 (i.e. RYD00018742); attached was Zip file plus Rev 03 of Exova Outline Fire Strategy. *Mr Hoban requested Part B observations; received B1 observations only but no disclosure suggests he questioned this.*
29/9/14	RBK00013223	BCB visits site. John Hoban. Satisfactory. Pre - start visit.
29/9/14	RYD00018989 SEA00000215	Email SEA to BCB (Hoban). Headed: fire strategy drawings - minor revisions : • Ground floor - community room (office and concierge removed) • Mezz: new apartment (office removed) • Walkway – 2 bed apartment in lieu of office STATES - Please see attached the "current Exova Study which was written prior to the Fire Strategy Rev B changes" and also attached the correspondence with Exova relating to the Rev B changes which "we will modify accordingly." *This was Exova Outline Fire Safety Strategy Issue No. 03 dated 7/11/13.*
29/9/14	RYD00018963	Email BCB (Hoban) to Rydon with attachments of emails relating to scheme to date. Headed - fire strategy P2.
30/9/14	JSW00001837	Email chain Wright and PSB with attachments regarding smoke ventilation system – alternative design proposal due to high velocities in ducts. Attachment was PSB Smoke Ventilation Technical Proposal for Stair Depressurization Systems Rev 0 issued for comment 22 April 2014. "Proposal is to design a depressurization system which will protect the stairwell by providing an airflow from the stairwell into the lobby when the stairwell/lobby door is open". Velocity across open door should be sufficient to meet the requirement for a Class B system as outlined in BS EN 12101 - 6. Includes calculation for air flow through open door; also includes inverter fans and stairwell ventilator 1.0m^2. Proposed to use all 4 of builders work shafts as mechanical extract. Introduction states having identified potential problems with proposed "push pull" system leading to excessive pressure drop due to high velocity existing ducts. Alternative is proposed.
9/10/14	CST00001007	Email TMO to various maintenance companies requesting urgent servicing of fire alarm, emergency lighting, extinguishers, dry riser, hydrant pumps and smoke extract BUT this was viewed on 6/10/14 and has been confirmed as beyond repair and is scheduled for replacement shortly so no action required.
17/10/14	RYD00021548	Email Wright to BCB requesting meeting re proposed smoke ventilation system.

10/11/14	RBK00033895	In response to an earlier request, BCB Hanson to BCB Hoban - observations in relation to B1 Means of escape referenced as S1. *Refers to fire strategy document MTY14652R, which is presumably MT14652R, i.e. Exova Strategy Rev 03.*
11/11/14	RBK00027326 RBK00027560	RBKC formal consultation request to FRS; 1st LFEPA consultation FP/14/03563 *No attachment to disclosed document. The RBKC MOE observations (dated 10/11/14) S1, are attached to the request.* B1 observations is an email dated 10/11/14 between Hanson and Hoban stating App. No. submission 1; submission no. S1; also refers to dwg no. 1279(08)101 01BS; 100 01 BS. and "marked up plans RBKC S1 where comments are added to the above plans".
12/11/14	MET00017799	Smoke Ventilation Technical Submission Lobby Smoke Control System Rev 0 ISSUED FOR APPROVAL. This revision incorporated a velocity flow across the stair door of 2m/s. *Not clear whether this was provided to BCB at any stage.*
14/11/14	RBK00003802	Email Hanson to Hoban giving amended S1 revised plans ("S1 revised" is subject of email heading) and suggests response to SEA noting significant difference due to omission of vented lobbies to single escape stair. Hanson suggested text that became S1 response to applicant - RBK00013226 dated 18/11/14. Drawings listed as 1279(08)101b and 100b
18/11/14	RBK00013226	BCB responds to BRegs application S1 Revised 2 Email John Hoban to Studio E referring to submission S1 . States "A decision notice will be forwarded to you shortly on the proposals submitted". Subject of email "Grenfell Tower, Grenfell Road Regeneration Project MOE Obs Submission 1 Revised 2". Also states the scheme was commented on at preliminary stage and these were identified as P1 and P2 submissions. Observations by Paul Hanson regarding escape and FRS access attached with marked up plans identified as S1. States as you (Neil Crawford at Studio E) have recently taken over the project; I thought it would be useful to highlight the most significant points below. They are also described in more detail in the observations and marked up on the plans identified as S1. JH highlights the most significant points of the scheme as : Revisions to preliminary scheme – • Revised residential use at walkway directly into stair without vented lobby - plans marked with suggested lobby • Natural ventilated lobbies to non-residential accommodation -

		alterations to scheme do not appear to have included the need for 0.4m^2 ventilation lobbies to revise central connection from the single residential stairway to the boxing club at walkway and office use at ground level • Significant matters outstanding from preliminary scheme • Extract rate for existing residential stairway lobbies to the newly extended residential units required justification • Access to the shafts from single stair to be avoided "the building regulations deal with the works proposed in an existing building and are limited to ensuring that no adverse effect takes place to any exiting situation. Your client does have however an overriding responsibility to provide adequate fire safety for the existing building under a separate piece of legislation called the regulatory reform(fire safety) order 2005 (RRO) which may involve upgrading the existing building. At preliminary meeting design team had highlighted a concern whether any refurbishment of the mechanical stairway lobby ventilation system would be suitable for the purpose of the RRO." Etc..... For the purpose of the submission S1 we will consult the fire authority under the building regulations in the normal way but it is important to understand that this consultation only relates to the new building work taking place and will give not reassurance to your client regarding how the existing building will be considered under the ongoing controls of the regulatory reform(fire safety) order. *NB Exiting - I believe this should read existing situation.*
18/11/14 Indicated on Relativity as document date	RYD00023970	Wright to various, including BCB requesting meeting to discuss the AOV system on 24/11/14. The email explains that the proposal is in two phases – first: natural system with new dampers, detectors and controls; second: fully mechanical including pressure sensors adds that the split is to get some form of working system as soon as possible with the intention of getting phase two completed within original construction programme.
20/11/14	EXO 00000206	Studio E to Exova requesting comments regarding BCO "mark-ups" and escape observations received from RBKC .
21/11/14	SEA00012200 RYD00024337	Email chain ending 21/11/14 between BCB/SEA/Exova re submission. Contains Exova comments regarding the S1 observations.
24/11/14	RBK00013223	BCB visits site. John Hoban and Paul Hanson. Satisfactory. Site meeting to discuss proposals.
27/11/14	RBK00013223	BCB visits site. John Hoban. Satisfactory.
12/12/14	LFB00000290	Email LFB response to RBKC request for consultation dated 11/11/14.

		Actual response letter not attached to email of 12/12/14.
01/6/15	EXO00000344	MF to Exova requesting comments re PSB proposal Rev 01); fundamentally different to MF specification as is now a pressure differential system rather than smoke clearance.
16/1/15	JRP00000168	BCB visits site referenced in John Rowan report No. 3
19/1/15	RBK00003838	Email Wright to BCB - PSB AOV technical submission. Attachments - PSB Technical Submission Lobby Smoke Control Systems Rev01; KEY-1pdf; osr Brochure pdf; pressure transmitter 1240 415 Rev F pdf; sc series[1]pdf; smoke vent slcs.pdf; Apollo smoke heads pdf *Rev 1 details - incorporation of Phase 2 details* *The smoke evacuation damper brochure (RBK00003845) states is tested to BS 1366-2 but no CE mark.*
26/2/15	RBK00003790	BCB email Hoban to Hanson requesting observations for attached proposals – 1279SEA (08) 101 Rev 04 Fire strategy with comment.dgn.pdf; 100 Rev05- Fire access with comment.dgn.pdf
6/3/15	RYD00034060 SEA00000247	Email Rydons to BCB and Wright with preliminary plans for lower floors and discussing AOV; adding still formalising AOV duct route and requesting acceptance of AOV proposal submitted by Wright email to BCB 19/1/15 *(this is PSB technical submission Rev 01).*
10/3/15	RYD00034397	EMAIL Wright to BCB Hanson confirming AOV meeting 17/3/15. Meeting request by Hanson to discuss. *The AOV is the mechanical smoke control system by PSB*
17/3/15	TMO00829504 RBK00027404	Artelia Minutes of meeting on 17/3/15. Notes in relation to Building Control meeting arranged for 17/03 for AOV sign off. BCB not present at Artelia meeting. States there is a structural issue with AOV's
10/4/15	CST00001258	Date of letter Stokes to TMO re visit to look at vent system being installed at lower levels. Seeks confirmation system has been accepted by authorities.
10/4/15	CST 00001769	Letter Carl Stokes to TMO regarding recently routed out edges to staircase fire doors fitting cold smoke seals and new hinges. Doors on all levels have been worked on. Includes photos. States this work started 19 March 2015 Will seals affect new smoke control system in lobbies? New hinges - no intumescent pads can be seen. Door seals - poor workmanship.

14/4/15	RBK00027394 RYD00038873	Email Wright to BCB re mech AOV . Attached amended technical submission i.e. PSB Rev 02 dated 14/4/15. Amended following meeting. JSW email states - "Please note: the key switch has not been changed due to awaiting a client decision, the key switch will therefore be subject to final confirmation, we can amend the tech sub accordingly and keep track of the changes if it does change. Hope this is acceptable."
11/6/15	PSB00000569	 To: Hugh Mahoney[hm@psbuk.com] From: David Bradbury Sent: Thur 11/06/2015 10:31:09 AM Subject: Grenfell AOV Building Control Comment Hugh, Paul Hanson from Building Control has just called, can we let him know asap if we mean the statement highlighted in yellow or can it be deleted and resumitted. He wants us to basically delete it as it doesn't tie in with what we have discussed with him. If we can respond quickly, we can avoid him rejecting the TS. Thanks. 1.1.2 Smoke Control Proposals Kind regards, Dave Bradbury Design Manager Head Office J S WRIGHT & CO LTD, CELEBRATING 125 YEARS, 1890 – 2015 Email JSW to PSB following query from BCB (Hanson) re clause 1.1.2, on basis that it does not reflect discussions. Highlighted text reads –"I should be noted that as the system is designed to extract air from the lobby via the open stairwell door, the system is not designed to comply with all the requirements of the aforementioned Code of Practice." [i.e. BS EN 12101 - 6]
11/6/15	RBK00003808	Email JSW to BCB (Hanson) - "Further to our telephone conversation , regarding the following statement in our technical submission".

		 Hi Paul, Further to our telephone conversation, regarding the following statement in our technical submission: 1.1.2 Smoke Control Proposals The Final smoke control system has been designed to provide the existing stairwell with protection from the ingress of smoke, from a fire within a dwelling, by means of a mechanical extract system. The system has been designed to provide an average open door velocity, across an open lobby/stairwell door of 2.0m/s. This velocity is in accordance with the recommendation for a Class B pressure differential system as defined in Code of Practice BSEN12101 Part 6: Specification for pressure differential systems – Kits. (bsen12101-6) I should be noted that as the system is designed to extract air from the lobby, via the open stairwell door, the system is not designed to comply with all the requirements of the aforementioned Code of Practice. The smoke control measures in the lobby areas will be implemented in two phases. Phase 1 will be to re-instate the natural smoke ventilation system consisting, of two natural smoke extract shafts and two natural air inlet shafts, with new motorised dampers in each lobby complete with a Programmable Logic Control System (PLC) I've left a message with Hugh but I know he's out of the office today so we'll get back to you as soon as possible. Kind regards, Dave Bradbury Design Manager Head Office Tel [redacted] I Fax [redacted] I Mob [redacted] I Email davidbradbury@jswright.co.uk I Web www.jswright.co.uk *The sentence suggests extraction is via the stair which was not correct; and would not have been acceptable.* The amendment details of Rev 02 - Item 2.2 change to natural air inlet ventilator (existing to be changed if not $1m^2$ in free area) and 3.1 Fan selection changed.
12/6/15	RBK00003808 PSB00000569 RBK00027396	PSB to Wright - PSB Tech submission Rev 03 with the paragraph removed as requested. Email was copied to RBKC- Hanson
24/6/15	RBK00003853	Email Hanson to Hoban re GT PSB Smoke Control Technical Submission REV 03 dated 12/6/15, with attachment MOE Obs S1a smoke control system –that records the comments are made using AD B and where appropriate BS 9991 and states "attached my comments regarding the smoke control system for the stairway lobbies; the proposals for which are satisfactory" The S1a observations states in the "comments to clients" that the components of the system should conform to the Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes) Revision 1 June 2012.

		This refers to Section 11.3 of the of the Guidance - BS EN 12101 Parts 2, 3, 6, 7,8,9 and 10.
16/9/15	RYD00051936	Email chain MF and others re secondary power supply for AOV system.
5/10/15	RBK00010784	Wrights advises others that Hanson will be on site 8/10/15. Subject of email is AOV Secondary Electrical supply
15/10/15	RYD00054618	JSW confirm taking AOV secondary power supply from Testerton buildings
18/12/15	RYD00062356	BCB (Hoban) to Dave Hughes confirming he and Hanson would visit 7/1/16
7/1/16	SEA00013781	"Accepted site meeting " Meeting accepted for 7/1/16 From SEA: required attendees- Hoban
7/1/16	TMO00831200	Rydon minutes of meeting with Building Control *Present - Hanson and Hoban. Clause 1.02 confusing as suggests upgrade of riser enclosure not required albeit wording says otherwise and goes on to say BC recommends upgrade doors to FD30s on risers, especially electrical. 2.01 states in respect of new flats that new front doors require one of the intumescent strips changed to a smoke seal.*
7/1/16 To 26/1/16	RBK00002978	Email 11/1/16 SEA to BCB (Hanson) attaching updated fire strategy drawings reflecting the final smoke venting solution … BCB (Hanson) to SEA cc Hoban – informed SEA that this was regarded as submission 2 and attached comments. Will consult LFB again "now as the scheme is acceptable in principle with matters of detail left to resolve, and I will do so adding the previously submitted powered vent specification". Also refers to small non FR cupboard. Drawings marked as S2 have drawing no. 1309 and entitled James Allen's Community Music Centre (RBK00002979 and RBK00002980)
26/1/16	RBK00002981	Memo Hanson to Hoban giving B1 Means of escape observations in relation to APP No.: Submission 2; Submission No.: S2 Drawing No: 1279 SEA ()8) 101 Rev 5- Fire Strategy, and 1279 SEA (08) 100 Rev 06 - Fire access. Also lists the Smoke Ventilation Technical Submission PSBUK1143-12 Rev 3, 12th June 2014 (for submission S1a) Makes comments using AD B "and where appropriate BS 9991". States - scheme was previously sent in for consultation, at the stage before the new powered ventilation was proposed. Powered ventilation system was sent in separately but decided to combine with current revised drawings. Existing system seems to have been an early hybrid push pull system, which appears to have powered extract; system to be removed. New system as set out in PSBUK1143-12 Rev 3, is considered satisfactory subject to conditions which should be read in conjunction with plans noted as S1. Under "Fire Authority Consultation" Hanson sets out under "Background"

		amongst other matters describes the existing and proposed systems as – Existing: appears to be an early hybrid push pull system, which appears to have powered extract. This is to be removed. The proposed new powered ventilation system is considered satisfactory subject to the "Comments for Client". The proposal involves the rerouting of the final exit from the single stairway and "RBKC have negotiated with the design team to ensure the stairway remains with ventilated lobby protection up to the final exit". Additional residential use at lower levels – at Walkway and Walkway +1, is protected by the powered ventilation system. New non-residential access to residential stairway – new Boxing club at Walkway level ; this submission proposed to use the residential ventilation system for the boxing club which is acceptable to fire loading in boxing club is compatible with residential type use. Small office at ground level will have $0.4m^2$ natural ventilated lobby where connected with stair. *The S2 observations reiterates in the "comments to clients" that the components of the system should conform to the Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes) Revision 1 June 2012.*
3/2/16	RBK00003776	Smoke Vent system Electrical Schematic PSB E 75015 800 E *No email; sent to BCB or was this disclosed by TMO?*
3/2/16	RBK00003779	Fans and damper operation 75015AG1 Rev04 *No email; sent to BCB or was this disclosed by TMO?* *The same document is the attachment Rydon to Hanson email 3/5/16 {RBK00003778}*
5/2/16	RBK00001413	Internal BCB email initiated by Paul Hanson requesting instigation of FRS consultation Subject refers to Fire Authority consultation S2. Implies this is the 2nd consultation.
5/2/16	LFB00000096	Joint Consultation procedure with LFB documentation. RBKC ref - FP/14/03563. States date application received as 5/8/ 2014; states statutory time limit is 9/9/14. Consultation request is dated 5/2/16. BCB states proposal is compliant subject to /with conditions.
12/2/16	MAX00002440	Technical submission for PSB Lobby Smoke Control Rev 04 dated 24 Feb 2016. Details of revision given as - AOV to Boxing Club and Communities Area (

		an AOV in each space; bottom hung window).
24/2/16	CST00001998 RYD00068839	PSB Smoke Ventilation Technical Submission Lobby Smoke Control Systems at Grenfell Tower Apartments, London Rev 05 dated 24/2/16. Amended to incorporate MF comments dated 18/2/16 *No indication Rev 05 was received by BCB.*
4/3/16	LFB00000291 LFB00000292	LFEPA response to consultation. LFB satisfied with proposals as shown. Scope described as New works to Grenfell Tower. No drawings or documents listed. LFB00000292(4/3/16) - email and letter attached of same date LFB00000291 4(/3/16) Email with response attached.
Period 23/2/26 - 09/03/16	TMO00830197	Rydon Progress Report No. 21 for period 23/2/16 – 9/3/16 States AOV system completed and commissioned for 4th - 23rd floors; interlink with BMS complete. Gnd - 3rd floors to be commissioned on 14/3; demonstrated on 17/3 *Nothing to suggest BCB involved*
15/3/16	RBK00003775	PSB Lobby Smoke Control Systems Rev 06 Amended to incorporate MF Comments 1/3/16
24/3/16	TMO00832681	M&E snagging list AOV's partial completion; full witnessing required.
1/4/16	SEA00014148	Email BCB Hanson to Studio E with LFB "positive" consultation response. (cc Hoban)
25/4/16	RYD00075492	Email invite to BC (Hanson and Hoban) to witness AOV system on 28 April. *Neither could attend {RYD00075511}*
1/4/16	SEA00014148 SEA00014150	Email RBKC to Studio E attaching FRS consultation response. Studio E email thanking RBKC for copy of LFB consultation *This was the 2nd FRS consultation.*
28/4/16	TMO00830679	This is an email string between the between 27th and 29th - TMO/MF/Rydon - including queries re cause and effect of AOV operation on other mechanical/electrical aspects. Email of 29th refers to "yesterdays" BMS demonstration and LFB request re installation of premises information box.
29/4/2016	RBK00048815	Rydon request to BCB to witness demonstration of smoke control system

		on 5/5/2016; states others including LFEPA happy with system
28/4/16	RBK00003785	PSB above ground smoke control commissioning undertaken and commissioning report of this date. Outcome - all systems are operating according to design *Not clear whether sent to the BCB or TMO*
3/5/16	RYD00076380	BC acceptance of AOV demonstration invite for Thursday 5 May 2016
3/5/16	RBKC chronology RBK00058146 JSW00001720	PSB signed smoke vent completion certificate. States system has been mechanically and electrically tested. And is fully operational in accordance with the agreed specification.
3/5/16	RYD00076415 RBK00048816 RYD00076682	Email chain on 5 May that includes disclosure by RBKC. Hanson queries test results from AOV demo he did not attend. Mr Hanson required test results in m^3/s. *Rev 03 with open door velocity of 2m/s was accepted by BCB subject to conditions that did not relate to flow measurement.*
3/5/16	RBK00003781	Email Rydon to BCB Hanson. Air speed readings for AOV. Attachments - GT readings in environmental mode, pdf,: sign off sheet; readings in fire pdf GT Rev02; C&E Rev 04' PSB Rev6.
Probably/ possibly 3/5/16	RBK00003782	Environmental mode readings in m/sec May be attachment to RBK00003781 above.
3/5/16	TMO00833300	Operation and maintenance manual for above ground smoke ventilation system. States - • Extract is via all 4 openings and make up is via stair that has permanent vent at head - penthouse louvre. • Vent lobby override (key) in stair; control panel for LFB in entrance area. • Pressure sensors onto each vent lobby. • Override switch on floor can be operated ONCE the control panel is initiated

3/5/16	RBK00003778	Rydon to BCB (Hanson) cc Hoban attaching - 75015AG1 GT Cause and EffectRev04,pdf and Grenfell Tower Tech Sub Lobby Smoke Control Systems Rev 6
4/5/16 5/5/16	RYD00076725 RBK00003773	Emails 4th and 5th May 2016, BCB (Hanson) and Wright GT Building Control Demo ATTACHMENTS - GT readings in fire, PDF; E75015-800E,pdf; 75015AG1 GT Cause and EffectRev04,pdf Rev 06 Technical submission Rev 06 was lobby smoke control system. Cause and effect rev 04 was the PSB Fan and Damper Operation Cause and Effect chart {RYD00071521}. 75015-800E is the PSB smoke ventilation Electrical schematic {RYD00076725} Wright sets out testing requirements based on Smoke Control Association Guidance for "pressure differential systems", *the test for which refers to open door velocity of not less than 2m/s. I And* "System to be set in environmental mode, and fire simulated to prove cause and effect."
4/5/16	RBK00048818	Email Hanson to Rydon stating readings should be m^3/s and testing should follow SCA guidance Section 9' and attached SCA guidance. *The details of the attachment are given as SCA Guidance on Smoke control to Common Escape Routes on Apartment Buildings pfd.*
5/5/16	RBKC chronology	BCB witnesses smoke control system *See the notes in Alan Whyte's Witness Statement {JSW00001892}*
12/5/16	RYD00077614	BCB visits site; email Rydon to BCB Hoban confirming outstanding issues. Issues relate to 3rd and lower floors. "See you on Thursday 26th May"
12/5/16	RBK00044894	Hoban Outlook entry - Grenfell Tower
25/5/16	TMO10045172	Emails 8/1/16 - 25/5/16 Stokes/BCB/Rydon re accepted FA in flats Email BCB Hanson 13/1/16 refers to separate references within RBKC- his and Building Control
25/5/2016	RBK00048842	Rydon to BCB querying outstanding issues pre site visit
26/5/16	CST00002705	Email chain between Stokes to Andy Jack at LFB re due diligence as BCO has put in writing that heat detectors not required in all kitchens of new flats and cold smoke seals not required to communal doors off of new lift lobbies at ground, 1st, 2nd and 3rd levels. MINUTES OF MEETING WITH BUILDING CONTROL BC requested that smoke seals should not be fitted to communal doors off new lift lobbies on Ground, 1st, 2nd & 3rd floors.

		AJ response : For the smoke seals we can enforce at any point after occupation – and we'd expect to see them. *CT did not give explanation as to why omission requested. See 5/7/16 – {RBK00002982}. See 10/4/15 {CST00001769}*
1/6/16	RBK00013223	BCB visits site JOHN HOBAN. Satisfactory Works outstanding including – instructions for LFEPA on how to operate powered ventilation system; outstanding paperwork for powered ventilation
1/6/2016	RBK00048847	Rydon to BCB requesting letter of comfort
2/6/16	JSW00000024	Rydon to BCB (Hanson) - linking of environmental AOV's in entrance lobby to allow make up air for bottom four lift lobbies - See 9/6/16 JSW00000030. Included in this chain is an email dated 26 May 2016 from PSB Jonathon Earl of JSW. **From:** David Harrison [mailto:David.Harrison@psbuk.com] **Sent:** 26 May 2016 14:01 **To:** Jonathon Earl **Subject:** Re: 75019 - Grenfell Tower, London - Summary of Results Hi Jonathan Following our discussion yesterday and just as a preamble for the smoke control system we have designed to provide the existing stairwell with protection from the ingress of smoke from a fire within a dwelling by means of a mechanical extract system. The system has been designed to provide an average open door velocity across an open lobby / stairwell door of 2.0m/s, this velocity is in accordance with the recommendation for a Class B pressure differential system as defined in Code of Practice BS EN 12101 Part 6: Specification for pressure differential systems – Kits. (BS EN 12101-6). The control system will also has pressure sensors added into each ventilated lobby to control the speed of the fans to ensure that when the doors on the escape route(s) are closed that the opening force on the door does not exceed 100N as detailed in BS EN 12101-6. this was witnessed by your Mr Alan Whyte and the 1 reading, which was not recorded in our commissioning sheets but read as 85N on the scale provided by J S Wright. To this end the system supplied and commissioned complies with the standards set out and has been accepted by all Consultants / Building Control & Fire officer's over time. We are not entirely clear or understand what additional information you wish to achieve above what has been carried out to date but I would be greatly appreciated if you could send any additional requirements requested by the building control and the consultant and what BS / document / standard they wish the system to achieve? I have attached our commissioning report which has been accepted by your Mr A Whyte.
2/6/16	RBK00013224	BCB (Hoban) letter dated 2nd of June 2016 to Rydon Maintenance Limited under the heading of the Building Regulations 2010 (as amended). App No. FP/14/03563. Details matters requiring attention/ completion following inspection "yesterday afternoon". The works appear to relate totally to the works of the lower levels, including - • "Various openable windows within the main entrance lobby to Grenfell Tower are required to be linked to main powered

		ventilation system for the building so that such windows open on operation of the system and provide make up air at the bottom shaft for the system.". • A permanent notice indicating how to operate the powered ventilation system adjacent control panel on ground storey for LFB use. Confirms that once matters mentioned in this letter completed also the outstanding applicable paperwork relating to the power ventilation system has been sent to this office consideration and the documentation has been reviewed and found to be satisfactory; this department "should" be in a position to issue the Building Regulations completion certificate for this project.
2/6/16	TMO 10045448 JSW00002901	Various emails between 2/6/16 and 22/6/16 (JSW, MF, TMO questioning/discussing BCB's requirement for additional AOV at ground level entrance lobby) referring to outstanding issues as listed by RBKC in letter (attachment) of 2/6/16 - includes notice giving instructions on operation of powered vent system for LFB etc. `` be in a position to issue completion certificate.
3/6/16	RBK00003037 RYD00080024	Email exchange BCB (Hanson) and Hughes re AOV test results queries. Email dates are 26 May, 2nd and 3rd June. Within chain is statement that although not recorded as part of commissioning certificate the force required to open doors was 85N. BCB (Hanson) queried the summary of results; wanted m^3/s. Made no other comment.
9/6/16	JSW00000030	Email chain contains email of this date where it is stated BCB (Hanson) concerned leakage around doors and opening doors may not always satisfy make up air.
13/6/16	RBK00002964	Rydon to BCB (Hanson) 2No windows under front entrance canopy to be changed to fixed louvres to allow make up air into entrance lobby.
2/6/16 to 16/6/16	RBK00002964 RBK00003024	Email chain starts 2nd June various parties including internal BCB (Hanson to Hoban) RE AOV, in particular vents at low level. Email subject - linking environmental AOV's to smoke extract Hanson concerns re door and opening doors not providing adequate make-up air: PSB suggest 1sqm free area vent to atmosphere in GL entrance lobby. Hanson states no objection to fixed louvre with added comment /reservation the permanent vent may be cause of cold and drafty in winter.
13/6/16 To 20/6/16	RYD00081016 MAX00006348	Email 13 June 2016: BCB and Rydon : amendment to smoke ventilation system – change 2no. windows under front entrance canopy to fixed louvres. Email 20 June 2016: BCB (Hanson) to Rydon no objection to fixed louvre of $1.0m^2$ geometric free area. *No explanation as to why 1.0sqm vent suggested by PSB was considered*

		adequate.
20/6/16	TMO10045704	FRA carried out on 20/6/16
20/6/16	CST00002867	Fire Risk Assessment
20/6/16	TMO10047764	Significant findings and action plan resulting from FRA by Stokes Record of significant findings and action plan. Copy attached. States is the findings from the Fire Risk Assessment. Finds/queries inter alia – • Dates of "extraction" and basement water pumps maintenance • Some fire doors no smoke seals; BCB has stated should not be fitted; obtain written confirmation • Intumescent strips on new doors painted over • Metal louvred door between ground floor lift lobby and shaft and electrical intake room • Flat 24 entrance door damaged – missing letter box • Flat 112 entrance door being replaced; cold smoke seals fitted • Level 16 – staircase door damaged • How is smoke vent in ceiling of ground level "off the lift lobby area in front of the electrical cupboard" • Adjacent flat 46 two smoke detector heads; 2nd device unknown to contractor • No instructions adjacent AOV control panel; how is panel accessed; no keys to operate the AOV individual override available • How is AOV outside ground floor electrical room activated - no smoke detector in area • AOV system and fire alarm system are remotely operated; what is procedure and policy if activated • Are weekly tests of smoke ventilation system being undertaken
22/6/16	TMO10045448	Emails re outstanding issues and smoke vent – Max Fordham's and Rydon
27/6/16	RYD00081525 RBK00044889 RBK00044890	Rydon query re time of meeting Hoban and Rydon on 30 June 2016 for final walk around Hoban Outlook entry -from Rydon 27/6/16 to Hoban - subject BC Completion Walkaround
30/6/16		BCB visits site *EVIDENCE of visit - referred to in {RBK00000132} and {RBK00002993}*
1/7/16	RYD00081891 RBK00000132	Rydon email to BCB Hoban - photos re fire door signs and rubber ramp following meeting previous day.
4/7/16	RYD00082020	Rydon to BCB Hoban - please issue completion certificate ASAP
4/7/16		Contractors completion meeting
4/7/16	RBK00018810	Certificate of practical completion

5/7/16	RYD00082205 RBK00002982	Email Rydon to BCB Hanson confirming intumescent seals and not smoke seals had been fitted to stair/lobby doors . Hanson had stated the new powered lobby ventilation system needs to draw air from the stairway and recommended omission of smoke seals to stair/lobby door; Rydon responds that intumescent strips were fitted in lieu of smoke seals *Hanson should have corrected Rydon - intumescent strips are not in lieu of smoke seals - See below.* Message **From:** David Hughes [dhughes@rydon.co.uk] **Sent:** 05/07/2016 13:41:05 **To:** Hanson, Paul: CP-Plan [paul.hanson@rbkc.gov.uk] **CC:** Hoban, John: CP-Plan [john.hoban@rbkc.gov.uk]; Steve Blake [sblake@rydon.co.uk] **Subject:** RE: Confirmation of BC instruction to not fit smoke seals to new lift lobby doors @ Grenfell Tower Hi Paul Thank you for your quick reply I confirm that we have fitted intumescent strips in lieu of the smoke seals Kind regards Dave David Hughes Site Manager T: M: [redacted] **From:** Paul.Hanson@rbkc.gov.uk [mailto:Paul.Hanson@rbkc.gov.uk] **Sent:** 05 July 2016 14:08 **To:** David Hughes **Cc:** John.Hoban@rbkc.gov.uk; Steve Blake **Subject:** RE: Confirmation of BC instruction to not fit smoke seals to new lift lobby doors @ Grenfell Tower Hi David, I confirm that due to the need for the powered lobby ventilation system to draw inlet air from the stairway, it is recommended that 'smoke seals' are not included on the doors between the stairway and lobby to enable the system to operate at full efficiency Note that this does not refer to any intumescent strips Regards Paul Hanson Senior Building Control Surveyor (Fire Regulations)
7 July 2016	RBK00018811	Building Regulations Completion Certificate issued.

139. A further insight into the process by which the BCB dealt with the smoke control submission can be found in the Witness Statements of the personnel involved.

<u>John Allen (Building Control Manager)</u>

140. In his first statement {RBK00033930} Mr Allen states he had some very limited involvement in pre-application enquiries concerning the smoke control system. Mr Allen reiterated this in his oral evidence on 5 October 2020.

John Hoban (Senior Building Control Surveyor - Project Surveyor)

141. In his first statement {RBK00033934} Mr Hoban says he made decisions in relation to B5, which he corrected in his second statement {RBK00050416} to say that Mr Hanson made decisions in relation to B1 and B5. He added that in these matters he deferred to Mr Hanson's experience and in effect Mr Hanson made the decisions.

Paul Hanson (Senior Building Control Surveyor in the "Means of escape group

142. Mr Hanson describes himself in paragraph 31 of his first witness statement {RBK00033894} as a consultant to the BCB providing advice in relation to means of escape, (Requirement B1) and, if requested, other matters, which was normally B5 (fire service access and facilities) on new buildings (paragraph 40). He states his involvement in relation to Grenfell Tower was only B1 (paragraph 46).

143. Mr Hanson goes on to state in paragraph 50 that in dealing with his B1 role he referenced Approved Document B Sections 1, 2 and 5 and for the lobby smoke control the Smoke Control Association Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes) dated June 2012. He states that having completed his review, he considered the B1 proposals were compliant subject to his comments on means of escape (paragraph 51).

144. Within paragraph 52 and onwards Mr Hanson sets out that (using the paragraph numbering in the statement) –

> 52: The new smoke control system was designed in accordance with the principles of the Smoke Control Association (SCA) Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes) dated June 2012 as there was no "current" British Standard for such systems although such systems were most common in new large residential buildings. He adds that SCA guidance does not specifically relate to existing buildings. In an existing building there is concern related to leakages from the structure that could reduce the extract rate.
>
> 56: JSW did not use a computer model and proposed using an "air leakage test" upon completion of the installation to show that the system achieved the objective of stopping smoke affecting the stairway.
>
> 57: The air leakage test followed the procedure in BS EN 12101– 6 where in the completed building a flow rate of 2 metres per second (2m/s) with "doors" open is to be achieved flowing from the stairway. The intention is to demonstrate that the physical building achieved this objective and any leakage in the structure that may exist does not detract from the extract rate. Mr Hanson does not specify which doors he refers to - whether at the fire floor or those at other levels.
>
> 58: "It should be noted that BS EN12101 - 6 is a code of practice for a "pressurisation" system where air is "blown" into the stairway and lobbies, and the system JS Wright proposed was an "extract" system – extracting air from the lobbies (a different system) - however the objective of the systems is to keep the stairway free of smoke for a fire on one floor and therefore the flow rate test was regarded as a practical solution."

59: "Therefore, computer modelling was not used as it would have been difficult to have confidence for a modeller (the person constructing the model) to predict possible leakages in the existing structure with any degree of certainty."

60: He had no involvement in the commissioning test. The commissioning results showed a flow rate exceeding 2m/s at all floor levels.

61: He cannot confirm compliance on site as inspection was not his responsibility. Certification was accepted for mechanical and electrical smoke control systems following the loss of RBKC's mechanical and electrical engineer.

62: There was a commissioning certificate but past experience indicated there "can be problems with "air inlet" functioning properly". He suggested to Mr Hoban that they attend a working demonstration. This demonstration was also attended by Alan Whyte on the 4 May 2016.

63: The demonstration on 4 May 2016 was limited to the sequence of operation of the system from activation of a small selection of smoke detectors in the lobby on a few floor levels. It did not involve a witnessing of the previously commissioned air flow rates; it was a demonstration of the sequence of operation.

145. The Inquiry will note that various disclosures and Mr Hanson's witness statement indicate some anomaly as to the date the system was witnessed. Mr Hanson refers in paragraph 63 of his witness statement to 4 May 2016; the email from J S Wright {JSW00000020} to Mr Hanson dated 4 May 2016 refers to "items to be demonstrated tomorrow". Within the same email chain the email dated 3 May 2016 from Rydon to Mr Hanson contains the line "Please let me know if you need any further information prior to Thursday." The 3rd May was a Tuesday; 5 May was a Thursday. During his oral evidence Mr Hoban in response to a question indicated "I may have, yes" attended a demonstration of the smoke control system on 4 May 2016 with Paul Hanson. (Transcript of oral evidence 1 October 2020, page 185, from line 5).

146. Continuing with Mr Hanson's witness statement, paragraph 64, it was discovered there was no air inlet at ground floor level as make up air to the ground floor "powered lobby vent". The installation of the AOV was confirmed subsequently by John Hoban. System otherwise performed as required.

65: He made no separate note of the visit.

72ff: Mr Hanson sets out the principles of the smoke control system. The relevant parts of which can be summarised as –

1) This extraction system is limited to a single fire on a single floor. It is a based upon the fundamental principle that multiple fires or fire spreading beyond the flat of fire origin does not occur.

2) The system does not operate on multiple floors.

3) "This principle of using smoke ventilation system was developed by the BRE (Building Research Establishment) in document B9204:2002."

The reference here to B9204 is incorrect; the reference should be *BRE project report 79204: smoke shaft protecting firefighting shelves; their performance and design.*

147. From paragraph 91 through to 147, Mr Hanson sets out his own chronology which can be summarised as –

17 August 2013: he and John Allan met the Studio E architect and Max Fordham's representative to discuss the changes to the lower levels. When Grenfell Tower was constructed few powered systems were around. He was asked if the existing smoke vent system was suitable but explained the role of the BCB was to ensure that the existing situation was made no worse. It was agreed the applicant would provide a full explanation as to how the existing smoke control system worked.

On 11 November 2013, the BCB responded to Max Fordham that further details were needed. On 6 December 2013 the BCB produced the P2 response {MAX00001399} commenting that the air change rate for the new system was considered unsuitable for stairway lobby protection. Two systems were under consideration – retain the existing (there being no scope under the Building Regulations to require improvements) or replace.

106: Mr Hanson states "Note: although "defend in place" strategy is employed in the existing building, lobby protection is necessary on the lower floors (as on all floors) to enable any occupant who wishes to escape to do so and also if the Fire Brigade decide to evacuate the building. The lobbies provide protection to the occupants escaping from the upper floors protecting the stairway against a fire on one level affecting the stairway."

107: Mr Hanson states information on the mechanical extract system was received from Max Fordham but no explanation as to how it worked. He discussed a response with John Allen, which resulted in an email chain explaining the required details.

114: The full plans application was not accompanied by details of the existing or proposed smoke control system and the list of required details was reissued. Mr Hanson also marked up plans to show an acceptable configuration of the lobby spaces at the lower levels. At this point the Fire Brigade was consulted and Mr Hanson states that "we" have no record of a response to this first consultation.

115: Studio E advised the system was to be replaced. Mr Hanson states: "This would then enable us to exercise control as this would be new work."

At the site meeting on 24 November 2014, attended by representatives of Studio E, JS Wright, Max Fordham, Rydon and Messrs Hoban and Hanson, it was explained the BCB would evaluate the system when submitted.

The review

148. On 26 January 2016, Mr Hanson provided observations for the second submission {RBK00002981}. The second submission observations (S2) addressed an amended layout and PSB Smoke Ventilation Technical Submission Lobby Smoke Control Systems at Grenfell Tower Apartments, Revision 03. The new smoke control system was accepted subject to conditions.

149. On 5 February 2016, the second consultation with the Fire Service took place on the scheme as a whole {LFB00000096} and the Fire Service responded on 1 April 2016 that they were satisfied with the proposals {LFB00000291} {LFB00000292}.

150. Mr Hanson states {RBK00033894} paragraph 128, that his consideration of B5 (Fire Service access and facilities) in respect of the project was limited to the smoke control system when it was decided to replace the system. He reiterates several times that his "consultation related to B1 only and subsequently B5 in respect of the smoke control system only".

151. In my opinion, as the existing smoke control system was protecting the stair as an escape stair and a firefighting stair, Mr Hanson should have considered any alterations/proposals as relevant under both B1 and B5 concurrently throughout his involvement with the refurbishment works.

152. A document dated 13 May 2014 {MAX00002335} "Smoke ventilation analysis Rev B" by Max Fordham set out by calculation a comparison of the existing and proposed (at that time) smoke control systems. This was not the final scheme (as the attached schematic indicates an office (designated EMB) at the Walkway level that was changed to a flat) and describes "The new fans will be sized to provide a minimum of $5m^3/s$ flow rate at the furthest point from the fans. This is in line with the current best practice for balanced "push – pull" type smoke ventilation systems, with the figure arising from a $3.5m^3/s$ flow rate through an open door to prevent smoke ingress from the lobby to the escape stair during escape plus an additional $1.5m^3/s$ allowance from the existing unlined builder's works shafts and remaining dampers on other floors."

153. As far as I have been able to ascertain to date this document was not seen by the BCB and did not aid their review of the final proposed scheme.

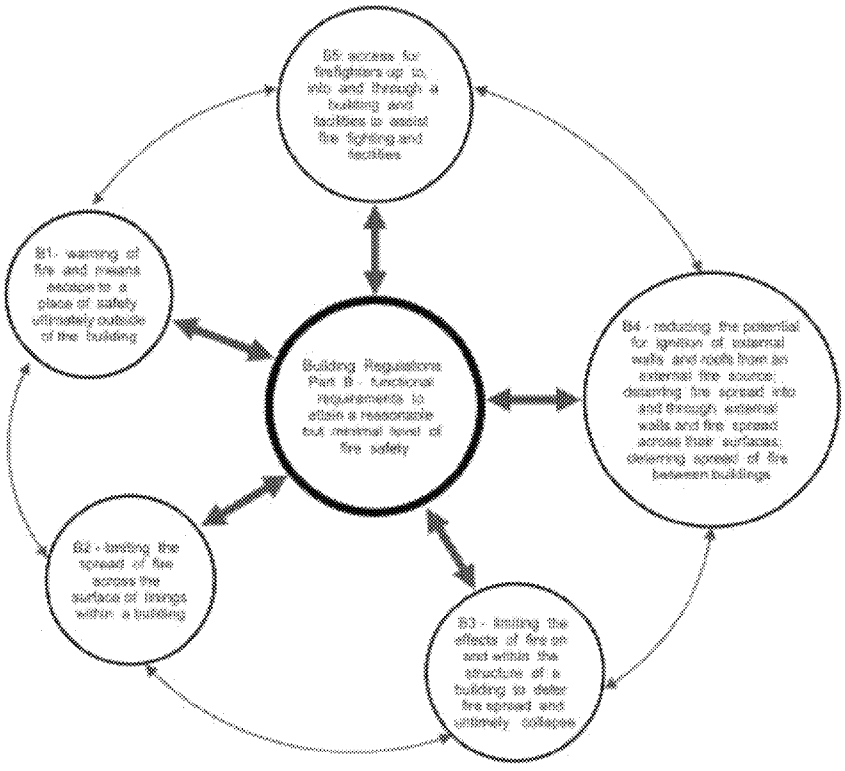
154. A building control body should make the decision whether a proposed system is appropriate in the circumstances. In the case of Grenfell Tower the aim was to maintain the single stair relatively free of smoke for escape (escape phase) and firefighting access and retreat (firefighting phase).

155. These phases are common in a residential block with a "stay in place" evacuation protocol and reflect the assumed actions/events that will take place in the event of a fire.

156. It is assumed that a flat fire will be restricted to the single flat by the compartmentation and other fire safety measures. As such the smoke control system need only be designed to cope with a single flat fire on a single floor at any one time.

157. Safe evacuation and firefighting access require the support of the other fire safety measures in Part B of the Building Regulations.

158. In reviewing the adequacy of a proposed smoke control system a BCB should ascertain the level of compliance/non-compliance of the general fire safety measures as they are all inter related and mutually supportive.



159. If one aspect of fire protection in a building does not conform to guidance, a misplaced assumption of compliance can render other protective measures inadequate or inappropriate. The circle of mutually supportive measures must be complete.

160. I am critical in my main report {BMER0000004} <228> as to what I consider to be the ineffective relationship/interaction within the Building Control Department. However, had Mr Hanson enquired as to whether other matters were compliant, I believe Mr Hoban at that time would have confirmed compliance or certainly a no-worse situation. Mr Hoban has stated in his witness statements and during oral evidence that at the time he believed the proposals, including the cladding, were compliant with the requirements of the Building Regulations.

161. I have described below the assumed escape and firefighting phases that guidance at the time supported. Both phases should have been considered by the system designer and the BCB.

162. Escape phase: The fire in the flat activates the smoke detection in the flat hall and on hearing the alarm the residents leave the flat. The escape through the common lobby is protected against smoke and fire by the compartmentation of each flat, including the self-closing fire resistant flat entrance door. The flat entrance door closes after the last person leaves and restricts/stops smoke passing into the common lobby. If the volume of smoke that passes through the flat entrance door as persons escape is sufficient to activate the smoke detection in the lobby, this will initiate the mechanical smoke extract that will dilute/remove smoke in the lobby.

163. As the system is activated in the common lobby the vent at the top of the stair opens to allow air into the stair as part of balancing/ effecting adequate smoke extract. The vent at Grenfell Tower was a permanently open vent not requiring activation.

164. Flat residents pass into the fire protected common stair and descend to the street and external air. The self-closing fire door to the stair closes after residents have passed into the stair, thereby minimising further smoke entering the stair.

165. The smoke extract in the common lobby protects the residents of other flats at the same level who wish to evacuate. Any smoke in the lobby is reduced/diluted by a combination of the extract and incoming air from the stair door when it is opened.

166. Firefighting phase: Fire fighters connect their hoses on a level or levels below the fire floor, enter the stair and proceed up to the level of the fire, opening the stair door into the lobby and proceed to open the door to the fire flat. In doing so they prop open the stair door with their trailing hose(s) increasing the air flow from the stair into the lobby (that is increasing the flow of input air above that provided by leakage around a closed fire door). The doors to the stairs at the lower level(s) where fire fighters connected their hoses and at the fire floor level are all propped open at the same time: potentially three open stair doors.

167. As fire fighters enter the flat the open door allows smoke to pass into the common lobby. The fire may be at its most intense by this time.

168. It is recognised (and commented on in various reports and guidance) that the only smoke control system likely to deter smoke from passing into the stair through the open door between the lobby and stair is a full pressurization system designed in accordance with the principles set out in BS EN 12101 - 6. As such it is anticipated that other systems will deter smoke entering the stair; reduce/minimise the amount of smoke entering the stair.

PSB Smoke Ventilation Technical submission for Lobby Smoke Control Systems Revision 03 dated 12 June 2015

169. The Smoke Ventilation Technical submission for Lobby Smoke Control Systems Revision 03 produced by PSB was regarded as part of the full plans application for the refurbishment works. It was designated as submission S1a within the BCB and formed part of the consultation process with the Fire Service.

170. This revision of the Technical Submission {RBK00027396} resulted from the following interaction between the BCB and JS Wright and PSB.

171. Revision 01 was issued to Mr Hanson (cc Mr Hoban) by email dated 19 January 2015 as the result of ongoing discussions {RBK00003838}. A meeting took place on 13 March 2015.

172. Revision 02 was submitted to Mr Hanson (cc Mr Hoban) by email dated 14 April 2015 - "following or meeting" {RBK00027394}.

173. Revision 03 was received following a telephone discussion between Mr Hanson and JS Wright when Mr Hanson queried the wording of clause 1.2.1 *Smoke Control Proposals*

of Rev 2 {PSB00000569}. JS Wright contacted PSB setting out that the BCB had queried the clause asking whether the highlighted statement was correct as it did not: "tie in with what we have discussed with him. If we can respond quickly, we can avoid him rejecting the TS". Clause 1.1.2 was reproduced with a highlighted sentence.

174. The highlighted sentence in clause 1.2.1 was -

"It should be noted that the system is designed to extract air from the lobby, via the open stairwell door, the system is not designed to comply with all the requirements of the aforementioned Code of Practice."

175. The "aforementioned Code of Practice" was BS EN 12101 - 6.

176. There is no indication that PSB queried the removal of the sentence in full or part. The omitted sentence had included "is designed to extract air from the lobby, via the open stairwell door" which would have been unacceptable. The remainder of the sentence appeared to describe the proposal - "It should be noted that the system is designed to extract air from the lobby, the system is not designed to comply with all the requirements of the aforementioned Code of Practice."

177. PSB omitted the sentence in full and issued Revision 03 to JS Wright copying in Mr Hanson {RBK00027396}.

178. Revision 03 describes the aim is to protect the stair from the ingress of smoke by means of a fully mechanical extract system, designed to achieve "an average open door velocity, across an open lobby/stairwell door of 2.0m/s. This velocity is in accordance with the recommendations for a Class B pressure differential system as outlined in Code of Practice BS EN12101 Part 6: Specification for pressure differential systems - Kits." It stated all four existing builder's work shafts would be used as part of the smoke control extraction system. "Make up air will be provided via the open lobby door."

179. The method for testing the open door velocity and opening forces on the door was said to be as detailed in BS EN 12101- 6.

180. It also describes the use of the shafts as natural day to day ventilation to the lobbies. A by-pass damper assembly will open and shut off the smoke extract fan and isolate the two shafts. One shaft will act as extract; the other as fresh air inlet. "A separate technical submission will be provided for phase 2 environmental systems which are linked to the smoke control system." I not seen a separate technical submission in the documents provided to me.

181. Class B is the class of system indicated in BS EN 12101 - 6 as appropriate for the means of escape and firefighting phases "to minimise the potential for the serious contamination of firefighting shafts by smoke during means of escape and firefighting operations."

182. There is no specific explanation/justification for the adoption of 2.0m/s within the Technical Submission. There is no reference to the rate being appropriate for both the escape and firefighting phases. It does refer to Fire Service override facilities on the floors. It only refers to protecting the stair from fire within a dwelling.

183. The submission does not state it is based on, reliant on, or has adopted the SCA guidance. The guidance is not quoted anywhere in the document.

184. The Inquiry will recall that in paragraph 50 of his first witness statement {RBK00033894}, Mr Hanson states that in dealing with his B1 role he referenced Approved Document B Sections 1, 2 and 5 and for the lobby smoke control the Smoke Control Association Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes) dated June 2012.

185. The B1 means of escape observation S1a {RBK00033900} subsequently produced by Mr Hanson in relation to Technical Submission 03, states "I make the following comments using Approved Document B and, where appropriate, BS 9991."

186. AD B Clause 2.27 set out that mechanical ventilation to the stair and/or lobby may be provided to protect the stair from smoke as an alternative to natural ventilation. Adding that guidance on smoke control systems using pressure differentials is available in BS EN 12101 - 6.

187. BS 9991: 2011 {CTAR00000040} was superseded by BS 9991: 2015 in October 2015 {BSI00000059}. The S1a observations were dated 14 June 2015. Both documents refer to the SCA smoke control guidance.

188. Clause 26.2.2 of the 2011 edition states that where a pressure differential system is not implemented, smoke control by mechanical smoke vent systems may be considered.

189. Annex A of BS 9991: 2015 and clause 14, Smoke Control, 14.1.3 in relation to single stair blocks exceeding 11.0m comments that for lobby access dwellings, smoke control should have one of the following - (c) mechanical smoke ventilation system in accordance with 14.2.4; or (d) a pressure differential system.

190. Mr Hanson would have had knowledge of both editions of BS 9991.

191. The proposal in Technical Submission 03 is not described as performance based in accordance with the SCA guidance.

192. Revision 03 set out the works would take place in two phases.

193. Phase One - would utilise the shafts without fans (the existing fans being removed) and the existing fresh air shaft extended through the plant room to an automatic opening vent (AOV) to external air. The retained shafts were to maintain a level of natural smoke venting of the lobbies on each floor during the works in the occupied building.

194. Phase Two - the installation would be made fully mechanical by the installation of fans with inverters and pressure sensors to deter excessive pressure across the stair doors - variable speed fans.

195. The "newly installed" fresh air make up inlet ventilator in the plant room wall will be removed and the opening blanked off. The resultant system would operate in smoke extract mode - four dampers to the four smoke shafts open to extract smoke and "make up air will be provided via the open lobby door" (which I believe was describing

the door between the lobby and the stair, taking inlet air from the stair which was provided with an existing permanent vent at its head.)

196. "The existing fresh air riser and smoke extract builders work riser will be connected together using galvanised smoke ductwork and fed to a single extract fan set as described above. I.e. all four existing builders work shafts will be used as part of the smoke control extraction system."

197. JS Wright later informed the BCB that the testing of the installation would follow the SCA guidance. However, the Maintenance Statement (clause 4.1) in Revision 03 refers to the recommendations of BS 9999.

198. Revision 03 stated that the mechanical system "will be designed to provide low speed trickle ventilation when the lobby doors are closed and to provide high speed ventilation when the door is open". It should be noted that the latter reference is to one door, suggesting that this is the door to the stair on the fire floor. "When the door is open air will be drawn through the open door at an average rate of 2.0m/s to provide smoke control protection of the stairwell".

199. I interpret this to mean that the described trickle ventilation was leakage around the stair door when it was closed and the automatic ramping up of the system when the stair door was opened.

200. Technical Submission 03 Clauses 3.2 and 3.3 Mechanical Control System described the opening of the four dampers on the existing 20 floors and two dampers on the ground floor, walkway and walkway mezzanine areas. It also gave details of the automatic lobby ventilators proposed in the lobbies to the "ground floor, walkway and walkway mezzanine".

201. Within Section 3.0, Phase 2 Equipment and Controls, fans are proposed at the roof above the Plant Room and at Walkway level.

202. This revision does not refer to the extension of the shafts. However, the referenced architectural plans indicate ventilation shaft inlets at the Walkway +1 level.

203. In paragraph 57 of his first witness statement {RBK00033894} Mr Hanson refers to an air leakage test upon completion of the installation, adding that it is the intention to demonstrate the "physical building achieves this objective" and any leakage in the structure that may exist does not distract from the extract rate. I take this to be the demonstration of air flow across open stair door at the fire flat level; and any unknown leakage path detrimental to the system would be indicated by /reflected in the results of an actual air flow test.

204. The design proposals as set out in the technical submissions aimed to achieve 2m/s air velocity flowing from the stairway at the open lobby stair door to protect the stair. In paragraphs 57 and 58 of his witness statement Mr Hanson stated "The flow rate test was regarded as a practical solution" to demonstrate the building achieved this objective. He added CFD modelling was not used as there would have been little confidence in the model predicting the existing leakages in the structure. The flow rate was recommended in BS EN 12101- 6.

205. The PSB electrical schematic drawing {RBK00003776} dated 25 May 2015, (before the S1a observations were made on 24 June 2015) indicated the upper floor shaft dampers and those at ground level and levels L01, L02 and L03 as smoke dampers. The drawing has a note that dampers are not within the PSB scope of supply - design, supply and installation of any damper.

206. Neither Technical Submission Revision 03 nor Revision 06 specified a fire rating for the smoke extract fans; only that they should be certified in accordance with BS EN 12101-3 Specification for powered heat and smoke exhaust ventilators.

207. SCA guidance recommends smoke extract fans should be tested and certified to BS EN 12101. It does not recommend a performance criteria. It recommends the actuators to ventilators should operate at a minimum of 300^{0}C.

208. Although not referenced in the S1a observations, Revision 2 of the SCA guidance, recommends that designers should clearly define the temperature rating of the smoke extract fans and provide a statement as to why the rating is appropriate.

209. There are no disclosed notes that describe Mr Hanson's review of Revision 03: any aspects he queried or considered required clarification.

210. In paragraph 51 of his first witness statement {RBK00033894} Mr Hanson states that having completed his review, he considered the B1 proposals were compliant subject to his comments on means of escape.

211. There are several aspects of the proposal that I would have expected an experienced BCB surveyor to have queried and/or clarified –

    (a) did the proposals follow any aspect of the SCA guidance (Mr Hanson having stated that the proposed system was designed in accordance with the guidance); if so why was it not referenced in the Technical Submission;

    (b) what was the temperature rating of the smoke extract fans;

    (c) what was the fire resistance of the proposed dampers to the smoke extract shafts;

    (d) were the dampers to the smoke extract shafts, the fire and smoke dampers required to maintain compartmentation and deter smoke spread.

212. I have seen no disclosure that indicates these issues were queried at the time of the BCB review.

213. It was common practice for a BCB to accept a smoke extract system with inlet air provided from the stair when the stair door was open to deter smoke from entering the stair. However, I would have expected that the need for doors other than on the fire floor to be open during firefighting to have been taken into consideration and be part of the BCB review/response to the proposals.

214. The Smoke Control Association Guidance was generally accepted by both building control bodies and fire authorities. Representatives of both were contributors to revisions 1 and 2. Whilst not having the status of an Approved Document or a British Standard it was recognised as meeting the demand for guidance regarding smoke control systems not addressed in either of these.

215. The SCA Guidance was referenced in BS 9991 as guidance on equipment specification and relevant test standards (Note to Clause 14.2.2.1).

216. BS 9991 also refers to other similar authoritative/recognised documents. For example, clause 0.3 refers to LACORS[7] Fire Safety, in relation to Houses in Multiple occupation. And CIBSE Guide E, Fire Safety Engineering.

217. AD B makes reference to various publications such as *Hardware for fire and escape doors 2006*, published by the then Builders Hardware Industry Federation and Guild of Architectural Ironmongers.

218. The Local Government Association publication *Fire safety in purpose built blocks of flats* was widely used at the time in relation to existing blocks of flats. This document was commissioned by the government in 2011.

219. I consider the SCA guidance was an appropriate reference in the circumstances: there was no other performance related guidance; no guidance that specifically related to existing buildings.

220. Following my review of Technical Submission Revision 3 I have concluded that the proposed system was a mechanical extract system designed to depressurize the lobby and induce an air flow from the ventilated stair into the lobby. In my opinion this satisfied the relevant aspects of Requirements B1 and B5 of the Building Regulations.

221. I do not believe the system described in Revision 03 was intended to be a pressure differential system designed in accordance with BS EN 12101-6.

PSB Smoke Ventilation Technical submission for Lobby Smoke Control Systems Revisions 04 and 05

222. Neither Revision 04 {MAX00002440} nor Revision 05 {RYD00068839} appear to have been submitted to the BCB.

223. Revision 04 dated 12/2/16: the revision details are listed as AOV to Boxing Club and Common Area added

224. Revision 05 dated 24/2/16: revision details are listed as amended to incorporate MF comments 18/2/16

PSB Smoke Ventilation Technical submission for Lobby Smoke Control Systems Revision 06 dated 15 March 2016

225. This document {RBK00003778} was issued to the BCB prior to Mr Hanson witnessing the demonstration of the system on or around 5 May 2016. It was attached to an email from JS Wright to Mr Hanson (Mr Hoban copied in) the day before the demonstration {RBK00003773}. In paragraph 63 of his first witness statement {RBK00033894}, Mr Hanson confirms his attendance at the demonstration. In paragraph 60 he confirms he was not present at the commissioning of the system.

[7] LACORS : Local Authority Coordinators of Regulatory Services

226. I have compared revisions 03 and 06 Technical Submissions. The main differences are set out in the table below.

227. The amendments in revision 06 appear to be a reflection of the later stages of the installation works.

Para ref	Revision 03 dated 12 June 2015	Para ref	Revision 06 dated 15 March 2016
1.1.2 Smoke control proposals	Smoke control measures to be implemented in two phases - Phase 1 natural smoke utilising the existing shafts; Phase 2 mechanical smoke extract	1.1.2 Smoke control system	Reference to phases removed
1.1.2	Once the signal is received all the dampers (extract and inlet air) in the smoke affected lobby will open and all dampers on other floors are to remain closed.	1.1.2	Once the signal is received all the dampers will close (extract and inlet air) and all four dampers in the smoke affected lobby will then open and all dampers on other floors are to remain closed.
1.1.2	Phase 2 will include ductwork alterations …….. Describes Phase 1 (natural smoke) and Phase 2 (mechanical smoke extract). Phase 2 will be implemented to convert the system into a fully mechanical extract system with a new smoke extract run and standby fan set	1.1.2	There are two pairs of smoke extract fans (one duty and one standby in each pair) one pair on the roof top plant room and one pair mounted within the new ductwork section on Level 02. There is also a single environmental fan located in the ductwork on Level 02. The environmental fan and the smoke extract fan on level 02 will have a set of bypass dampers so that in the environmental mode the smoke fan is isolated from the system and in smoke mode the environmental fan is isolated from the system
Para ref	**Revision 03 dated 12 June 2015**	**Para ref**	**Revision 06 dated 15 March 2016**
1.1.2	Mechanical Smoke Extract Phase 2 … A bypass damper to allow a separate environmental fan system to be linked to		The mechanical system will operate ….. The environmental system will operate ……

	the smoke shafts to provide day to day ventilation.		
1.1.2	Final paragraph: A separate technical submission will be provided for Phase 2 environmental systems which are linked to the smoke control system.		No such statement
2.2 Natural air inlet ventilator Roof opening over stairwell	The existing penthouse louvre is to be checked to ensure it has a minimum measured area. No photographs.	2.2. Roof opening over stairwell	The stairwell has been provided with a penthouse louvre .... is permanently open.
2.3.1 Control System Philosophy statement	Refers to natural extract shafts and natural air supply shafts	3.1 Control System Philosophy statement	Has added - If the environmental system is operating at the time of smoke detection in any lobby, the environmental fan will be de-energised the environmental bypass damper at walkway level will close and all lobby AOV dampers will close. Refers to both pairs of smoke extract fans.
Para ref	**Rev 03 dated 12 June 2015**	**Para ref**	**Rev 06 dated 15 March 2016**
2.3.3.4 Modular battery back-up panel	Location: Service riser existing lobbies every 5th floor	2.3.3.4 Modular battery back-up panel	Location: service riser existing. Text refers to every 5th floor
3.3 Mechanical Control System	The mechanical system will operate as described above for the natural system as follows		The mechanical system will operate as described above and the mechanical environment system as follows .....

5.0 Appendices	5.1 product data sheets - 7 listed	5.0 Appendices	5.1 Annex 01 - Fans and damper operation 5.2 PSB E 75015 800 Rev E Electrical Schematic

228. Rev 06 clause 1.1.2 describes a mechanical extract system designed to provide "an average open door velocity, across an open lobby/stairwell door of 2.0m/s. This velocity is in accordance with the recommendation for Class B pressure differential system as defined in Code of Practice BS EN 12101 Part 6".

229. "There are two pairs of extract fans (one duty and one standby in each pair) one pair on the roof top plant room roof and one pair mounted within the new ductwork section on level 02."

230. There is no reference to separate phases in the body of the submission as was described in Revision 03, but clause 2.0 is headed "Phase 1 equipment and controls" and clause 3.0 is headed "Phase 2 Equipment and Controls" (all as Rev 03).

231. Revision 06 contains details of those components associated with a smoke extract system, details of the equipment and a recommended testing and maintenance schedule based on BS 9999:2008.

232. "The Boxing club and common room lobbies" are described as having a single wall mounted AOV fitted in each space, operated from a dedicated smoke detector. "Smoke detected in a lobby only the applicable ventilator will open and the main mechanical system will remain unchanged."

233. The BCB inspection notes do not indicate at what stage the new shaft vents were installed so I have not been able to ascertain from these if Phase 1 was completed by the issue date of Revision 06. Granville Partlow (the PSB commissioning engineer) states in his witness statement that Revision 06 was finalised during the commissioning {PSB00001309} paragraph 23.

234. Both Revision 3 and Revision 6 refer to the existing penthouse louvre over the stair requiring a free area of 1.0m^2 or replacement of it to achieve the same.

235. Both revisions included the use of the shafts for environmental control of the temperature within the lobby, the operation of which is locked out on activation of smoke detection in the lobby.

236. As far as I can ascertain, the BCB did not issue comments in relation to Revision 6. It was not accepted or rejected by the BCB.

237. Revisions 03 and 06 were not significantly different. However, I would have expected the BCB to have commented in relation to revision 06 if only to acknowledge and record whether it was acceptable as an updated technical submission reflecting that previously accepted and as a description of the finally accepted and installed system.

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[8] BS 9999: 2008 Code of practice for fire safety in the design, management and use of buildings.

Consultation with the Fire Authority

238. This aspect of the Building Regulations process is set out in my main report {BMER0000001} < 461>.

239. Smoke Ventilation Technical Submission Revision 03 formed part of the second consultation with the Fire Service dated 5 February 2016 {RBK00033897}. The details also described the final layouts of the lower levels.

240. The consultation request was sent to the Kensington and Chelsea Fire Safety Team North West Area at 169, Union Street. This was the Area Team; not the Fire Engineering Group. Mr Hanson described the smoke control system as "a powered ventilation system". The pro-forma used by the BCB indicated that this was a means of escape consultation; the works were "standard" (as opposed to the other listed options of "simple" or "complex"); and that it was a fire engineered solution; the application complied "with conditions"; the proposed decision under B1 would be conditional.

241. The Fire Service responded that they were satisfied with the proposals.

242. The Fire Service response was dated 4 March 2016 {LFB00000292} and came from Fire Safety Regulation 169 Union Street. The covering email was from an Inspecting Officer at Westminster East Fire Safety Team Fire Safety Regulation SW. It is not evident from the disclosures if the consultation had been passed to another Team due to the Area Team workload, or if the other Team had specialist knowledge. No aspect of the consultation appears to have been dealt with by the Fire Engineering Group.

243. As far as I can ascertain, there is no disclosure that indicates the detailed findings of the Fire Service Officer. The disclosed documentation only indicates "The Brigade is satisfied with the proposals as shown."

244. The Fire Authority was at liberty to direct the request to any of their offices without reference to the BCB.

Inspection of the works

246. In my main report {BMER0000004} <513> I explain that a local authority building control body is not obliged to inspect works but that disclosures indicate that at least fourteen (14) <154> inspections took place. I concluded that the recorded notes were of insufficient detail <529>.

247. Below I have listed the date of those inspections set out in the BCB management control system (Acolaid) that had notes indicating they related to or could have related to fire/compartmentation and/or the smoke control system:

- 27/11/14: discussed fire compartmentation - service penetrations between flats.
- 1/6/16: resultant letter required linking of ground floor window to smoke control system to provide input air.

248. The Inquiry will note that the witnessing of the smoke control system in May 2016 is not recorded on Acolaid.

249. In paragraph 147 of his first witness statement {RBK00033894} Mr Hanson states he carried out no site inspections.

250. This suggests he did not consider the demonstration on site as described in paragraph 63 of his witness statement as an inspection. I fail to understand the implied difference. Mr Hanson did more than witness the smoke control sequence of operations; he noted a "missing" vent.

251. The operating sequence formed only part of the new smoke control installation. The new dampers to the existing shafts were critical to the correct system in preventing fire and smoke spread between floors and to maintain the compartmentation on which the "stay in place" evacuation protocol was based.

252. No BCB disclosure indicates that the temperature rating of the fans was queried on site - it was displayed on a plate on each fan (Dr Lane's report {BLAS0000031}). There is no indication that the fans were inspected on site; nor that the extract shaft fire dampers were inspected to establish their fire resistance was adequate to maintain compartmentation.

253. It should be established who within the BCB was responsible for checking on site that those aspects of compartmentation associated with the smoke extract system; and who if anyone did check the fire rating of the dampers/ventilators to the shafts and their installation.

254. In paragraph J10.1.18 (i) of her report {BLAS0000031} Dr Lane concludes that the dampers installed in the vents to the smoke shaft were not certified fire dampers, nor certified smoke control dampers and has identified the extract fans as having a 300^{0}C performance temperature for 60 minutes.

255. Dr Lane also highlights (paragraph J7.1.115) that the fire rating of the smoke control shafts was not specified in the PSB Technical Submissions. As the alterations to the shafts were limited to replacement of the smoke ventilators (dampers) and the extension of the shafts, I consider it was reasonable for the BCB to accept the existing concrete shafts as providing an adequate level of compartmentation for the upper

levels. The extension of the ducts to serve the lower levels was part of the architectural details.

256. Although not a part of the BCB, the Witness Statement of Mr Allan Whyte, an employee of JS Wright is informative of the actions /involvement by the BCB {JSW00001892}.

He states (using the paragraph numbers within the statement) –

52: From his dealings with Mr Hanson he believed he was very knowledgeable regarding smoke ventilation systems.

54: He liaised directly with building control in May 2016.

71: The extension of the ventilation shaft was undertaken by Rydon; the fire rated AOV ductwork in the main lobby was undertaken by others.

80: When the system was installed and finished the Technical Submission was at Revision 6.

82: The initial commissioning certificate related to floors 4-23, as the lower levels were not completed.

91: The basic operating instructions for the system were displayed at the system control panel as required by the BCB (John Hoban).

111: The first "AOV" demonstration took place on 28 April 2016. It was attended by the London Fire Brigade but not the BCB.

114: An email to the BCB (Hanson and Hoban) dated 29 April, recorded the "demonstration" the previous day.

115: A copy of the system's full commissioning was provided by PSB in a report dated 28 April 2016.

116: The PSB O&M manual was dated 3 May 2016.

124: All this information was passed to the BCB by email dated 4 May 2016.

128: He met with Mr Hanson on 5 May 2016 for a demonstration of the "AOV system operating in smoke mode".

131: Mr Hanson tested the opening of the stair door and he was "able to open it without too much difficulty".

132: Mr Hanson was satisfied with the results of the demonstration.

135: Mr Whyte was informed that building control had issued a letter dated 2 June 2016 (by email) following the site inspection by John Hoban on 1 June listing six matters that required attention.

136: Another matter raised was the "linking of the openable windows in the main entrance lobby to the Tower to be linked to the main powered ventilation system for the building so that such windows open on operation of the system and provide make up air at the bottom of the shaft for the system". A fixed louvre solution was approved.

257. The Inquiry will note that there is no recorded BCB description/record of Mr Hanson measuring the opening force of the door and that the results did not exceed 100N.

258. Mr Hanson maintains in his first witness statement {RBK00033894} paragraph 61, that it was not his role to inspect works and cannot confirm the installation complied with the accepted proposals. In paragraph 63 he states he attended the demonstration of the system on 4 May 2016; and that was limited to "a demonstration of the sequence of operation". He has stated elsewhere that as a "consultant" he did not make notes.

259. The following section of this report sets out the actions leading to the acceptance of the smoke control installation.

Analysis of decisions by building control

260. In his second witness statement {RBK00033903} paragraph 4, Mr Hanson states that receipt of commissioning certificates without any further inspection was the practice for mechanical and electrical systems at that time as there was no longer a mechanical and electrical surveyor/engineer within the Building Control Department.

261. The commissioning report for the whole smoke control system is dated 28 April 2016.

262. No fan installation and commissioning certificates appear to have been received by (or requested) by the BCB.

263. The PSB above ground commissioning report has been disclosed under {TMO10021475}. Mr Alan Whyte of JS Wright states in his witness statement {JSW00001892} that the final commissioning reports/test sheets were passed to Messrs Hoban and Hanson by email dated 4 May 2016 {JSW00001907}. The same email and its attachments can be seen at {JSW00006202}. The commissioning report is not signed.

264. Mr Hanson in his first witness statement also states (paragraph 60), that JS Wright provided a copy of the commissioning certificate to building control. The email referenced by Mr Hanson {RBK00027368} refers to an attached "sign off sheet", but there is nothing attached to the disclosure. However, this is duplicated in {RYD00076522} which has the attached "sign off sheet" and it is the Commissioning Report that states the system was operating in accordance with the design intent.

265. Commissioning of a system is to ensure/test that the system works with the associated equipment and systems. It is not a check on the standards of the individual components. The commissioning was undertaken by PSB, under the supervision of Granville Partlow. Mr Partlow describes the extent of the commissioning in his first witness statement {PSB00001309}. This indicates that the commissioning was an electrical and operational check of the system. In paragraph 42 Mr Partlow states that grilles obstructed a clear view of the dampers in the shafts. "However, I did check that the dampers were fitted correctly and that the actuators were connected into the correct connector on the outstation"; and that two or three dampers did not work and the installer was recalled to correct faults.

266. In paragraphs 6, 7 and 8 of his second witness statement {PSB00001372} Mr Partlow clarifies that the report titled "Above ground commissioning report" dated 26 February 2016 {PSB00001257} was an "interim report" and not intended to demonstrate full or partial commissioning as not all works to the system had been completed by that date. On page 4 of that report it states it is not a full commissioning report it covers only floors 4 to 23. It has Mr Partlow's electronic signature but not that of the client.

267. In paragraph 13 of his second witness statement {PSB00001372} Mr Partlow states that the Method Statement for the commissioning was inadequate but he had based his commissioning on the Technical Submission Revision 06 and not the Method Statement.

268. Dr Lane comments on the recommended/required commissioning of a smoke control system and the commissioning undertaken at Grenfell Tower in Section J8 of her report {BLAS0000031}.

269. The introduction to the SCA Guidance Revision 01 recommended that when a system has a dual purpose (that is during both escape and firefighting modes) consideration should be given to the different conditions of the operational modes.

270. The Scope section of SCA Guidance Revision 02 stated the document gives "test procedures for the systems used, as well as describing relevant and critical features of the installation and commissioning procedures needed to implement the calculated design in a building. It covers systems intended to protect means of escape from common escape routes such as stairwells, corridors and lobbies, as well as systems intended to protect fire service access routes."

271. Whilst neither version of the SCA Guidance specifically stated the stair doors on the lower floors should be considered as being open in addition to those at the level of the fire, a competent building control surveyor familiar with smoke control systems supporting firefighting operations and the particular scenarios associated with a Class B installation would have been aware of the need to consider additional doors being open.

272. The commissioning report does not indicate that the different operating modes were addressed as part of the commissioning process.

273. Dr Lane comments {BLAS0000031} that the commissioning of the system does not appear to have included all those doors that would be open during firefighting operations.

274. The BCB did not attend the commissioning of the system. In his first witness statement {RBK00033894} (paragraph 63) Mr Hanson confirms his attendance at a demonstration in May 2016. Mr Hanson's description of the sequence of operations witnessed does not refer to doors at levels below the fire floor being open at the same time as those on the fire floor.

275. I have seen no disclosure that suggests the BCB required open doors other than on the fire floor as part of the commissioning of the system or the witnessing of the system. There is no indication that the BCB took these additional doors into consideration when reviewing the smoke control proposal.

276. In his witness statement Granville Partlow (PSB commissioning engineer) refers to his involvement in a demonstration on 28 April 2016, that was witnessed by persons that included two London Fire Brigade personnel and at least one building control officer {PSB00001309} paragraph 15. However, in paragraph 47 of his second witness statement {PSB00001372}, Mr Partlow states that following sight of further JS Wright documents he believes no building control officer attended on 28th April.

277. On 2 June 2016 the BCB advised Rydon {RBK00013224} of outstanding matters that included linking the main powered ventilation system for the building to openable windows within the main entrance lobby to provide makeup air at the bottom of the shaft for the system. This issue was resolved by the contractor proposing fixed open louvres of an area of 1.0m² (as recommended by PSB) in the entrance hall. PSB commented that the system as installed without this vent inlet had achieved the design criteria. To conclude the matter the contractor proposed the fixed louvre and the BCB determined that the installation was satisfactory.

278. The 1.0m² fixed louvre vent appears to have been accepted without justification of the size.

279. In paragraph 64 of his first witness statement, Mr Hanson states "It was discovered that no inlet air vent was provided at Ground floor level (to serve as makeup air to the ground floor powered lobby vent). I was later told by John Hoban (the Area Surveyor) that the missing inlet air vent had been added, this was achieved by an automatically opening vent (AOV), via a window at ground floor level, opening into the stairway, the AOV triggered by smoke detection in the common lobby at that level."

280. Mr Alan Whtye states (paragraph 136 {JSW00001892}) that on 2 June 2016 he received an email with a BCB letter attached referring to a site inspection by John Hoban on 1st June raising matters that required attention. This included the "linking of the openable windows in the main entrance lobby to the tower to be linked to the main powered ventilation system for the building so that such windows open on operation of the system and provide make up air at the bottom of the shaft for the system".

281. The BCB letter referred to can be seen at {RBK00013224}; the windows are referred to in item 5 of the list displayed.

282. The BCB disclosures and those by others to date do not make it clear to me –

    (a) when the missing vent was discovered (May or June)

    (b) if the vent was the AOV to the lobby between the stair and the accommodation at ground level indicated on the BCB annotated S1 plan-fire access plan 1279 (08)100) {RBK00033895}; or,

    (c) if the BCB had expected an additional AOV in the ground floor entrance lobby.

283. On 5 July 2016 {RBK00002982} Rydon sought confirmation from Mr Hanson of his "instruction" not to fit door smoke seals to the lift lobby doors. By email of the same date Mr Hanson confirmed his "recommendation" in relation to the doors between the stairway and lobby "to enable the system to operate at full efficiency."

284. The Inquiry will note Rydon referred to Mr Hanson's "instruction". Mr Hanson refers to his "recommendation". It is not unusual for a BCB comment to be interpreted as an instruction as the applicant's aim is to complete the work and gain the Completion Certificate. There are no details of the conversation(s) that led to the email from Rydon and their assumption of an "instruction". In <539> of my report {BMER0000004} I am critical of the records retained by the BCB in all aspects of the building control process.

285. Whilst it was/is normal practice to omit ambient temperature smoke seals on stair doors where a pressurization system is installed, I am of the opinion that these smoke seals at Grenfell Tower should have been provided/retained. This is because the integrity of the fire door was important as a line of defence to the stair. The input air from the stair was required when the stair door was open during escape and throughout firefighting operations when hoses would prop open the doors, making the omission of the seals un-necessary. The PSB Technical Submissions included pressure sensors located in each ventilated lobby to control the speed of the fans to ensure closed escape doors could be opened with a force not exceeding 100N. The sensors are referenced within the Commissioning Certificate as pressure switch PS01 to PS24 "auto operate OK" and "pass".

286. The smoke seals would not have prevented all air being drawn from the stair when the door was closed; and there was no seal to the bottom of the door.

287. I believe that some BCBs would have supported Paul Hanson's recommendation that smoke seals be omitted. As such, whilst I do not agree with it, in my opinion Paul Hanson's recommendation cannot be said to fall below the standard to be expected of a reasonably competent BCB.

288. The disclosures do not indicate if the ambient temperature smoke seals were fitted to all the stair doors when the installation was commissioned. I note that in his oral evidence on Day 27 (transcript p.201-202) David Hughes (Rydon) confirmed that Rydon did not fit smoke seals to the stair doors on levels 4-23 of Grenfell Tower, adding "that was done" by the KCTMO contractors.

289. The disclosures reveal the following time line:

- The commissioning report for the whole system dated 28 April 2016.
- The "witnessing" of a demonstration of the system by the BCB on 4 or 5 May 2016.
- BCB Letter dated 2 June 2016 referring to a site inspection by John Hoban on 1st June and raising matters that required attention, including the linking of the openable windows in the main entrance lobby to the tower to the main powered ventilation system.
- Email chain on 5 July 2016 when Mr Hanson confirmed his "recommendation" not to fit smoke seals to the doors between the stairway and lobby "to enable the system to operate at full efficiency." This was after the system was commissioned.

290. The proposed design of the smoke extract installation incorporated the adoption of the recommended velocity of at least 2m/s at the open lobby/stairwell door for the class of system appropriate for means of escape and fire fighting in BS EN 12101 - 6 (Class B). In my opinion the adoption of this flow rate as a design principle was reasonable in the circumstances. However, whilst readings established the design flow was being attained I have not seen any disclosure that indicates that the BCB sought confirmation of, confirmed or witnessed the physical path of the air (smoke) movements away from the stair and that there was no significant inflow from other leakage paths such as the fire flat.

291. In my experience systems are generally demonstrated on site using a cold smoke test to illustrate the directional flow of smoke, the speed of dispersal and level of visibility. Whilst this will not fully replicate an actual fire situation, it will be indicative. As far as I can ascertain this was not suggested/undertaken.

292. In his witness statement Mr Hanson states certificates were accepted for mechanical smoke control systems. He does not state that he accepted this certificate. Nor is there any indication that Mr Hoban accepted the certificate.

293. In my opinion the issue of the Building Regulations Completion Certificate dated 7 July 2016, indicates the commissioning certificate dated 28 April 2016 was accepted albeit alterations to the installation were required by the BCB after 28 April 2016.

294. I have seen no indication that a further commissioning test was undertaken or required by the BCB for the altered system.

295. I have seen no disclosure that indicates that the BCB witnessed another demonstration of the system to confirm that the additional vent and omission of the stair door smoke seals was not detrimental to, effected the efficiency of the system or influenced the movement of smoke in the lobby at each level.

296. I am not satisfied that the issue of the makeup/input air in the ground floor entrance was resolved.

297. I have concluded that the commissioning report did not relate to the system as installed. As such the commissioning report should not have been accepted as part of the evidence of compliance that resulted in the BCB issuing a Building Regulations Completion Certificate dated 7 July 2016.

The BCB actions taken in relation to Regulation 38 Fire safety information

298. This matter is addressed in <476 > of my main report {BMER0000004}.

299. The smoke control system was a significant part of the fire safety measures at Grenfell Tower and required correct and adequate information for its operation, testing and maintenance.

300. The disclosed above ground Smoke Ventilation Manual {TMO00833300} is incomplete.

301. I concluded in <491> and <492> of my main report that there is no indication that the BCB was given a copy of the information required by Regulation 38; that the BCB was

not provided with nor sought assurances/evidence that such information had been issued to the "responsible person". This included information relating to the operation and maintenance of the smoke control system.

Conclusion

302. I agree with the view that a reliable CFD model may not be possible with an existing structure if the possible leakage paths have not been established. The "air leakage test" referred to in paragraph 56 of Mr Hanson's first witness statement {RBK00033894} is not detailed in any document. I believe this is his description of the air flow rate through the stair door, but this should be confirmed.

303. The adoption 2m/s flow rate at the open lobby/stairwell door was appropriate. This was the flow rate recommended in BS EN 12101 - 6 as the necessary performance criteria to protect persons escaping and fire fighters.

304. Having considered the disclosures to date I have concluded that the Technical Submission for the smoke control system as conditionally accepted by the BCB (Revision 03) was acceptable in principle - that is a performance based strategy was acceptable in the circumstances of an existing building with retained smoke extract shafts.

305. A number of matters in Revision 03 of the Technical Submission should have been clarified. This clarification process would have acted as a record of the BCB's review of the proposal. See paragraph 211 above.

306. Technical Submission Revision 6 was submitted to the BCB. The BCB did not accept or reject it, nor comment in relation to it. As such there is no record if this submission reflected the accepted system. See paragraph 237 above.

307. It was not unusual for a BCB to accept a commissioning certificate as evidence of compliance provided that the certificate related to the system as installed.

308. I am not satisfied that the issue of the makeup/input air in the ground floor entrance as required by the BCB was resolved. It is not clear whether the "missing" inlet air vent was part of the PSB technical proposal or subsequently required by the BCB (see paragraphs 279 to 282 above). I consider it was a failing of the BCB not to have obtained a record of the accepted smoke control system for future reference by the BCB, the applicant and the "responsible person" under the Order. In <536> of my report {BMER0000004} I am critical of the records made and retained by the BCB.

309. In his witness statement Mr Hanson states certificates were accepted for mechanical smoke control systems. He does not state that he accepted this certificate. Nor is there any indication that Mr Hoban accepted the certificate.

310. I have seen no indication that further commissioning of the amended smoke control system was undertaken.

311. I have seen no disclosure that records the BCB required/ did not require further commissioning. I believe it was a failure on the part of the BCB not to require further commissioning and not to have witnessed a further demonstration.

312. The issue of the Building Regulations Completion Certificate dated 7 July 2016, implies the commissioning certificate dated 28 April was accepted albeit alterations to the installation were required by the BCB after this date. I am of the view the certificate should not have been accepted by the BCB as evidence of compliance.

313. As such I have concluded and reiterate my view that a Completion Certificate for the refurbishment works should not have been issued by the BCB. <530> of my report {BMER0000004} refers.

DECLARATION

I understand that my duty in providing this written report and evidence to assist the Inquiry, and that this duty overrides any duty to any other party.

I confirm that I have no conflict of interest of any kind, other than any which I have already set out in this summary of findings. I do not consider that any interest which I have disclosed affects my suitability to give expert evidence to the Inquiry on any issue on which I have given evidence and I will advise the Inquiry if, between the date of this summary and the Inquiry hearings, there is any change in circumstances which affects this statement.

STATEMENT OF TRUTH

I confirm that I have made clear which facts and matters referred to in this report are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

Signature:

Beryl Menzies  FCABE PPBEng CBuildE CABE MRICS